ENVIRONMENTAL STATEMENT

FOR

TRIAL BOLL WEEVIL ERADICATION PROGRAM

U.S. DEPARTMENT OF AGRICULTURE

ANIMAL PLANT HEALTH INSPECTION SERVICE

WASHINGTON D.C. 20250

JUN 1976

USDA ENVIRONMENTAL STATEMENT

Trial Boll Weevil Eradication Program

Prepared in Accordance with

Sec. 102(2)(C) of P.L. 91-190

Summary Sheet

Draft ( ) Final (x)

U.S. Department of Agriculture

Animal and Plant Health Inspection Service

Contact: F. J. Mulhern, Room 316-A, U.S. Department of Agriculture, Washington, D.C. 20250, telephone (202) 447-3668.

1. Administrative (x) Legislative ( )

2. The proposed action is to conduct a 3-year trial boll weevil eradication program on approximately 260,000 acres of cotton in Virginia, North Carolina, and South Carolina to determine if the technical and operational requirements for eradication can be executed successfully in a large-scale operational program. The boll weevil is the most important agricultural pest in the United States. It costs cotton producers and the U.S. economy $200 to $300 million annually in losses and control. Approximately one-third of the insecticide applied in the United States each year for control of agricultural insect pests is for boll weevil control.

   The population suppression technology that will be utilized in the trial program involves the integration of chemical, biological, and cultural control measures in a precisely timed program.

3. Scientific data have established, and are reported in the environmental statement, that the use of the population suppression techniques that will be employed in the program will result in no excessive or irreversible impact on the environment.

4. Alternatives considered to the proposed program are: (1) Organizing and implementing an areawide boll weevil management program; (2) Continue present control strategy where growers apply repeated pesticide treatments throughout each growing season.

5. Federal, State, local agencies, and other parties from which comments have been requested:

   Agricultural Research Service, Economic Research Service,
   Extension Service, Cooperative State Research Service,
   Agricultural Stabilization and Conservation Service, U.S. Department of Agriculture

   Environmental Protection Agency

   Experiment stations, 13 States involved

   Environmental and Conservation organizations

   Cooperative extension services, 13 States involved

   State departments of agriculture, 13 States involved

   Cotton producers and producer organizations

   The general public

   See Appendix J for mailing list

6. The draft statement was made available to the Council on Environmental Quality and the public on July 25, 1975.

USDA-APHIS, (ADM)-75-1

Trial Boll Weevil Eradication Program

Environmental Statement

F. J. Mulhern, Administrator
Animal and Plant Health Inspection Service

U.S. Department of Agriculture

Washington, D.C. 20250

Appendices

CONTENTS

Figures

Tables

USDA Animal and Plant Health Inspection Service Environmental Statement*

Trial Boll Weevil Eradication Program

Prepared in Accordance with Section 102(2)(C)

of Public Law 91-190

Type of Statement:	Final
Type of Action:	Administrative
Responsible Official:	Frank J. Mulhern, Administrator, Animal and Plant Health Inspection Service, U.S. Department of Agriculture, Washington, D.C. 20250

I. DESCRIPTION

The boll weevil, *Anthonomus grandis grandis* Boheman, is an introduced species from Mexico which entered the United States near Brownsville, Texas, in approximately 1892 (60). It advanced across the Cotton Belt at 40 to 160 miles a year and by 1922 had infested more than 85 percent of the cotton production area of the United States (69).

This spread covered the limits of cotton production up the eastern seaboard. Spread to the west has been much slower and the boll weevil is presently established east of a line from the Texas High Plains into the Big Bend region of south Texas. As shown in Figure 1, this area

---

* There are a number of references cited in this document which are listed in the appendix and which are incorporated by reference into this Statement. Such references are identified herein as (1) and (2), etc. All of such references have been thoroughly considered in connection with preparation of this document, even though there is not set forth in the Statement a detailed analysis of each reference and each item of information contained therein.

covers all or parts of 13 States which produce approximately two-thirds of the cotton produced in the United States.

Further spread to the west is presently being retarded through the use of a boll weevil reproduction-diapause insecticide control program on infested cotton acreage adjacent to uninfested acreage on the Texas High Plains, and along the Rio Grande north of Presidio, Texas (3). This program was initiated in 1964 by the U.S. Department of Agriculture and the Plains Cotton Growers, Inc., when weevil infestations were found on the High Plains around the edge of the Cap Rock along with economically damaging populations in the Rolling Plains to the east. This program has been successful in preventing the boll weevil from further spread and establishment on the High Plains and in the cotton-producing areas to the west.

The boll weevil is generally recognized as the most economically important agricultural insect pest in the United States. In the years since the boll weevil entered the United States, it has caused losses to the nation's economy estimated to total more than $12 billion. Current annual losses are estimated to range from $125 to $224 million (4). Moreover, an additional $50 to $75 million is spent each year for insecticidal control of this pest. Greater quantities of insecticide are applied in the United States each year for control of the boll weevil than for any other insect or insect complex.

The adult boll weevil is grayish to brownish in color and is an average of 1/4 inch long including the snout (69). The life cycle and developmental periods vary somewhat depending upon location and climatic conditions (35, 46, 62, 69, 107). The adults hibernate in a state of diapause (21) in ground litter and woods trash along the edge of woods, turnrows, and fencerows, and emerge from hibernation from March 1 to July 1 or later. Starting in the spring and continuing throughout the fruiting stage of the cotton, the female weevil lays eggs singly in punctures made within squares (flower buds) and bolls. From early to midseason, squares are preferred for oviposition; whereas in the latter part of the season, eggs are laid in both squares and bolls. The developmental period from egg to adult is influenced by temperature and is shortest in midseason. The eggs which are laid in the square or boll hatch into larvae in 3 to 5 days. The larvae feed for 7 to 14 days within the square or boll and then change into pupae. The pupae develop into adults in 3 to 5 days. The adult upon emergence from the square or boll, feeds for 3 to 7 days (preoviposition), mates, and begins laying eggs for the next generation. The development of weevils in bolls may be three times longer than in squares.

Under favorable climatic conditions, eight generations could develop each year (27, 84). Generation-to-generation increases in the midsouth average five-fold and range from one to nine point six-fold (82). This rate of increase varies depending on the location and climatic conditions.

Cotton production losses result from adult feeding on squares and bolls and the development of larva in the squares and bolls. Each female lays 130-175 eggs over a 30 to 40 day period. Normally only a single egg is laid in a square and each female may oviposit in five to seven squares/ day (46, 62, 84). The number of squares damaged by each feeding male is considerably less since they move very little. From 65 to 89 percent of the fruit damaged by the weevil abscises and falls to the ground (84). The damaged fruit remaining on the plant generally does not produce cotton.

Boll weevils disperse primarily as airborne adults (31). Movement from hibernation sites is usually steadily across a field, but adults may fly to distant portions of a field or to distant fields. Throughout the summer, movement within a field and from field to field occurs apparently as a result of random flights by adult weevils. The greatest movement of adults occurs in the spring as adults emerge from hibernation and in the late summer and fall from mid-August to frost. This late season movement occurs due to a search for food and oviposition sites, and in search of hibernation sites. There is limited information on the distance that weevils may fly. The greatest distance recorded for a wild weevil in nature is 45 miles (37) and 33 miles for a marked, released weevil (28, 29). It is likely that a few individuals may exceed these distances.

The boll weevil belongs to a genus of weevils that develop on host plants in a narrow taxonomic range (7). Reproduction has been recorded only on plants of several genera within the tribe Gossypicae of the family Malvaceae. Species of only three genera that occur within the range of the boll weevil in the United States (Gossypium, Cienfuegosia, and Thespesia) are considered significant hosts (33). Gossypium spp. occurs as cultivated cotton throughout the boll weevil's range and as wild cotton in south Florida. Cienfuegosia spp. are restricted to south Florida and a narrow strip along the Texas lower Gulf Coast. Thespesia spp. occurs in south Florida and in extreme southern Texas. All of the malvaceous species which occur in south Florida are apparently sufficiently isolated from the boll weevil so they do not become infested. Thespesia spp., as an ornamental tree, in extreme south Texas has marginal survival and is consequently only a sporadic host. Cienfuegosia drummondii along the Texas lower Gulf Coast is the most important alternate host in the United States. Hibiscus syriacus, which is a marginal host, occurs throughout the southeast as dooryard plantings. Limited natural infestations occur on H. syriacus when the plant is growing near cotton that is heavily infested with the boll weevil; but, it is not considered a significant alternate host. Therefore, in the United States, with the exception of C. drummondii along the lower Gulf Coast, host plants of the boll weevil other than cultivated and perhaps volunteer cotton are considered unimportant.

There are numerous species of parasites and predators that attack the boll weevil. Forty-two species of arthropods have been identified as parasites (30). A study of boll weevil parasites in Georgia cotton fields in 1929 showed that they killed an average of 10 percent of the weevils in June, 14 percent in July, 18 percent in August, and 35 percent in September (100). Results of other parasite surveys conducted in the 1920's and 30's were variable with the percentage of weevils being parasitized throughout the season ranging from 3.5 to 16.0 percent with *Bracon mellitor* Say being the predominant species present in most cases (68, 89, 106). A 1965 survey was conducted throughout the boll weevil infested area of the United States and compared to a similar survey made in 1934-35 by the Bureau of Entomology, Cotton Insects Research Laboratory at Tallulah, Louisiana (25). In 1965 parasitism in the coastal plains region averaged 7.15 percent compared with 26.68 percent in the hill region. Fields treated with insecticides had 3.8 percent higher parasitism of the boll weevil in 1965 than most untreated fields in 1934. Comparison of the 1934-35 survey and the 1965 survey indicates that parasitism had markedly increased from an average of 4.05 to 12.77 percent.

Insect predators of the boll weevil include at least 20 species which attack the immature stages and 6 species which attack the adults (52). It is important to note, however, that these insects prey on a large number of species other than boll weevil. Some of the more important predator groups are ants, dragonflies, clerids, assassin bugs, ground

beetles, and spiders (111). In fallen squares mortality due to predators (mostly ants) amounts to 2 percent which is less efficient than for parasites (106). Also, at least 66 species of birds are known to prey on the boll weevil (9). Birds, such as the purple martin, *Progne subis subis* (Linn.), may destroy many adults in late season migration (111).

Although many naturally occurring biological agents attack the boll weevil, they are not capable of consistently suppressing populations below economically damaging levels and generally are of little consequence (86). This is primarily due to the biology and behavior of the boll weevil. The egg is deposited inside the square allowing the larva to develop in a protected environment unexposed to enemies (48). For this reason, biological control is not nearly as helpful in controlling the boll weevil as it is in the case of many other insect pests.

Significance

The boll weevil which occurs in the United States is an introduced species from Mexico which spread throughout the region now known as the boll weevil belt. This area includes all or parts of 13 States extending from west Texas to Virginia in which approximately 11 million acres of cotton are grown (Fig. 1). As this insect spread through this area over a period of approximately 22 years, it inflicted damage exceeding that caused by any other cotton insect. The boll weevil continues to be the most damaging pest of cotton today. It is currently responsible for losses and control costs to the cotton industry and the nation's economy

that range from $200 to $300 million annually, depending on the severity of the infestation, the acreage, and the price of cotton.

Indirectly, the boll weevil is responsible for much of the damage caused by the bollworm (*Heliothis zea* Boddie), the tobacco budworm (*Heliothis virescens* Fabricus), and spider mites, because insecticides used to control the boll weevil destroy many of the natural enemies of these species (94, 97, 98, 110). This, in turn, often results in higher crop losses and even more intensive use of insecticides to protect the crop from these formerly secondary pests. It is estimated that the need for insecticidal control of the bollworm-spider mite complex may be reduced by 75 percent if insecticides for boll weevil control were eliminated (4).

Cotton is the fourth most important crop in the United States, providing more than $4 billion in farm income to some 200,000 growers (41). Over five million Americans live wholly or mostly on income from cotton, with 12 million more receiving income from industries related to cotton. Cotton supplies consumers with 42 percent of their clothing, 25 percent of the textile products used in home furnishings, and 24 percent of the fibers for industrial uses (41).

Cotton is a renewable resource requiring only one-fifth as much energy to produce as synthetic fibers which are derived from oil and natural gas. Appendix A gives detailed information on the value and uses of cotton.

Although many natural biological agents attack the boll weevil, none are effective in consistently suppressing populations below economically damaging levels (95). Following its introduction into the United States, this pest was the limiting factor in cotton production until discovery that it could be controlled with the arsenicals and later the synthetic organic pesticides. The arsenicals were used extensively for control until the discovery of effective chlorinated hydrocarbon insecticides in the late 1940's. In the mid-1950's the weevil developed resistance to the chlorinated hydrocarbon insecticides (103). Today only one class of insecticides is effective--the organophosphates. Since natural biological agents, resistant varieties, and cultural practices, for the most part, are ineffective in suppressing weevil populations below economic damage levels, the broad spectrum organophosphate insecticides are routinely applied during the growing season to reduce damage. If we should lose these insecticides, either through the development of genetic resistance or through regulatory action restricting their use, tremendous economic losses would be inflicted to millions of acres of cotton each year (5). The economic losses would increase even more should the boll weevil be allowed to move westward onto the Texas High Plains and into New Mexico, Arizona, Nevada, and California (3). In severely infested areas, when cotton is not protected from attacks of the boll weevil with insecticides, yield reductions of 50 to 60 percent have been recorded (5). Should the organophosphate insecticides become unavailable, it would not be economical to produce cotton in fully one-half or

more of the Cotton Belt. This narrow base of crop protection poses a serious threat to the future of a commodity worth more than $4 billion per year in the United States at the farm level.

The boll weevil is the key cotton pest in most of the Cotton Belt where it is established since it is the pest that requires chemical control year after year. Once chemical treatment is started, it must be repeated periodically throughout the growing season to control subsequent weevil generations and the resulting secondary pests such as the bollworm-tobacco budworm complex and spider mites. As long as the boll weevil, which is not readily susceptible to natural control factors, remains in the cottonfield, the options of practicing pest management approaches against other pests are very limited. If a complete pest management program were practiced for the secondary pests, most of which are readily susceptible to natural biological control agents, the boll weevil would rapidly destroy the cotton crop. The boll weevil must be eliminated as an economic factor before other pests can be controlled effectively and efficiently by biological agents. The only way to eliminate the boll weevil in this context is to eradicate it from the cotton-growing regions of the United States.

The intensive use of insecticides for control of the boll weevil and other cotton pests has contributed considerably to environmental pollution in our southern and southwestern agricultural areas. The continued intensive use of insecticides by growers in the production of cotton may

pose questions as to the immediate and long-range effect on fish and wildlife. The adverse effects on beneficial arthropods such as bees, parasites, and predators may be even more acute and are more readily apparent.

Most experts on the boll weevil agree that eradication of the boll weevil is fully justified because of the losses it causes and because of the adverse side effects resulting from the insecticides needed to achieve control (73).

Federal Involvement with the Boll Weevil

Research to develop effective and acceptable ways to control the boll weevil has been underway by Federal, State, and industry organizations since 1892 when the pest entered the United States. In spite of research on almost every conceivable approach, insecticides remain as the only positive control method. Because other control methods remained less promising, the research up until the early 1960's was devoted to developing more effective chemical controls and better ways to use them. When the boll weevil developed resistance to the organochlorine insecticides in 1955, and the potential of this pest to make cotton production noneconomical in the absence of adequate control measures, the cotton industry urged an intensified research program to develop alternative control methods.

Congress appropriated funds for the U.S. Department of Agriculture, Boll Weevil Research Laboratory, which began a broad cooperative research program at Mississippi State, Mississippi, in 1962. At the same time, boll weevil research was intensified at other Federal laboratories and at State agricultural experiment stations and universities. The purpose of the research program was to develop a better solution to the boll weevil problem and to investigate methods of control that might lead to eradication from all infested cotton-growing areas in the United States.

This research effort has produced a number of promising new concepts and methods for control which include: (1) A better understanding of the overwintering or diapause of the boll weevil, and the development of methods for manipulation of diapause populations to reduce overwintered boll weevil numbers (20, 21, 82, 87, 104); (2) Less expensive methods of application of pesticides in ULV formulations for large-scale programs (23, 26, 77, 83, 88); (3) The development of traps for survey, suppression, and detection of weevil infestations (31, 32, 62, 76); (4) Pheromone or sex attractant for use in traps and trap crops (22, 55, 93, 103, 107); and (5) The development of the sterile insect concept for suppression and elimination of low level populations (38, 39, 80).

A Special Study Committee on Boll Weevil Eradication was formed by the National Cotton Council of America in 1968 to consider actions that should be taken if and when research advanced to the stage that boll weevil eradication might be technically and operationally feasible and

practical. The Committee was comprised of U.S. Department of Agriculture, State experiment station, university, and producer representatives, see Appendix G. On May 6, 1969, this committee met in Memphis, Tennessee, and after reviewing the progress of research and development, concluded that suppression techniques may have already been developed to the extent that eradication could be achieved when applied in an integrated program. However, it was pointed out that an adequate pilot experiment would be necessary to determine the technical and operational feasibility. Accordingly, a special subcommittee was appointed to consider the requirements for a pilot boll weevil eradication experiment and to select a location or locations for it. The committee recommended that a pilot test be conducted in south Mississippi, extending into adjacent parts of Louisiana and Alabama (1). This site was selected as being representative of, if not, the most difficult area in the Cotton Belt to achieve eradication.

The National Cotton Council Special Study Committee accepted the recommendation of the subcommittee and the following organizations participated in a 2-year pilot eradication experiment.

Contributors	Funding
U.S. Department of Agriculture	
Animal and Plant Health Inspection Service	
and Agricultural Research Service	$2,518,243
Cooperative State Research Service	1,087,000
Cotton Incorporated	1,087,000
Mississippi State University	
(Boll Weevil Rearing Facility)	560,000
	$5,252,243

In addition, the staff of the ARS Boll Weevil Research Laboratory and the experiment stations in Texas, Louisiana, Mississippi, Arkansas, and Alabama devoted a substantial portion of their research efforts in direct support of the pilot experiment.

The experiment was conducted under the general guidance of a Technical Guidance Committee appointed by the Office of the Secretary, U.S. Department of Agriculture, in July 1971, see Appendix H.

The Pilot Boll Weevil Eradication Experiment was initiated July 1, 1971, and terminated August 10, 1973. The technology applied in the pilot eradication experiment utilized the integration of chemical, biological, and cultural control measures (2, 14). The suppression measures utilized were as follows:

1. Inseason control with insecticides.

2. Late season reproduction-diapause control.

    a. Insecticide

    b. Destruction of food by defoliation and stalk destruction

3. Pheromone traps baited with grandlure.

4. Trap crops of cotton baited with grandlure.

5. Release of sterile boll weevils.

The results of the pilot experiment demonstrated that eradication was obtained in the southern two-thirds of the eradication zone (15, 80, and Appendix B). This portion of the area had at least 25 miles isolation (insecticide-treated buffer area) from cotton with established boll weevil populations. Incipient infestations were detected in 34 locations in the northern portion of the zone. This area was adjacent to cotton with established boll weevil populations, thus, making it susceptible to reinfestation by inward migration of weevils. These incipient infestations were eliminated by prompt spot treatment with insecticides.

Following completion of this experiment, the Technical Guidance Committee concluded, "that it is technically and operationally feasible to eliminate the boll weevil as an economic pest in the United States with techniques that are ecologically acceptable" (Appendix C).

At the request of the Technical Guidance Committee, an appraisal and evaluation was also conducted by a six-member Special Committee appointed

by the President of the Entomological Society of America (Appendix D). In its report the committee interpreted eradication to mean reduction of a specified population (in this case boll weevils in the eradication zone) to zero. The committee was divided as to whether or not a distinction should be made between accomplishing eradication or demonstrating feasibiltiy of eradication. They concluded that eradication had not been accomplished, but that populations were so low that they could not be detected in most of the eradication zone. The Committee as well as some scientists were also divided as to whether or not technical feasibility of eradication had been demonstrated and unanimously expressed reservations concerning any massive eradication effort without further refinement of the suppression techniques (96). However, their report stated that the major difficulties with a massive eradication program would be, "those of an operational nature (particularly people problems) rather than of a technical nature."

The results of the pilot experiment led the National Cotton Council's Special Study Committee for Boll Weevil Eradication to appoint a Technical Subcommittee to develop an overall plan for boll weevil elimination (see Appendix I). State and Federal research, extension, and regulatory agencies and the cotton industry were represented on the committee. A general plan was developed based upon research and the operational experience gained in the pilot experiment (4). It was adopted by the parent committee on December 4, 1973. The plan was designed for the guidance of the agencies and groups that would be involved if a national

elimination program were undertaken. It presented two alternatives for initiation of a national program: (1) Begin the program in Virginia and the Carolinas and work westward; or (2) Begin the program in northwest Texas and work eastward. After considering both the advantages and disadvantages of a national program starting in one of the two areas, the committee recommended that it start in northwest Texas. The primary reasons for recommending this area were: (1) It is considered one of the easiest areas to work operationally, and (2) Operational personnel have 10 years experience in boll weevil suppression in this area allowing time to train personnel for the more difficult southeastern area (3). The main disadvantage is the possiblity of reinfestation of the cleared area from Mexico; whereas reinfestation from the flank would not be a problem in Virginia and the Carolinas. However, this area (and the remainder of the Southeast) is considered to be the most difficult area of the entire boll weevil belt in which to execute the eradication procedures.

The overall plan for a national program to eliminate the boll weevil from the United States was presented by the cotton industry to the Secretary of Agriculture in December 1973. At the time of the presentation of this plan, the Secretary was urged to initiate an eradication program under the provisions of the Agriculture and Consumer Protection Act, Public Law 93-86. Following this request by the cotton industry, the Department of Agriculture held a series of conferences with State and Federal research, extension, producers, and regulatory officials who

would be involved in such a program to determine interest at the State level and willingness to participate. It was anticipated that such an undertaking would require the complete support of all the State and Federal agencies and the cotton industry to achieve eradication.

In the course of these discussions, an alternative program was proposed. This program consisted of the execution of a 3-year trial eradication program in either west Texas or in Virginia and the Carolinas. The purpose of this trial program was to further prove the effectiveness of the suppression measures in actually achieving eradication and to further refine the suppression measures in order that the cost of such a program would be reduced, and the likelihood of success would be enhanced. This trial program would also test our capability to handle the logistics and detailed execution of the program on a large or operational scale.

This 3-year trial eradication program was discussed with the agencies which would be involved in west Texas, Oklahoma, and Virginia and the Carolinas. As a result of these discussions and an evaluation of the two areas as potential trial sites (see Appendix E), the decision was made to develop the information necessary to make a decision as to whether or not to undertake a trial program in the Virginia, North Carolina, and South Carolina area. Accordingly, this environmental impact statement has been developed for a 3-year trial boll weevil eradication program for Virginia and the Carolinas.

Plan of Action

A trial boll weevil eradication program will be conducted in the cotton-growing areas of Virginia, and the Carolinas to determine if the technical and operational requirements for boll weevil eradication can be executed successfully on a large scale. The eradication program area will consist of approximately 1,000 acres of cotton in Virginia; 99,000 acres in North Carolina; and 160,000 acres in South Carolina for a total of 260,000 acres. Approximately 90-95 percent of this area is coastal plains, with 5 to 10 percent rolling hills. Field sizes range from 7 to 15 acres in Virginia and North Carolina to 20 to 30 acres in South Carolina. Figure 2 shows a map of the proposed eradication program area.

In selecting this area over the northwest Texas area as recommended by the National Cotton Council Boll Weevil Eradication Committee (4), several criteria were considered (Appendix E). The two criteria that carried the greatest weight were economic benefits to producers and creditability of success in an area applicable to the entire boll weevil belt.

For implementation and execution, the area has been divided into two parts and into two time periods for execution (Fig. 2). The area within the concentric circles includes the approximately 1,000 acres of cotton in Virginia and 44,000 acres in North Carolina or a total of 45,000 acres. Program operations will be executed over a 3-year period

from 1977 through 1979. The cotton acreage outside the circles includes 55,000 acres in North Carolina and 160,000 acres in South Carolina. Program operations will begin on this acreage 2 years later in 1979 if evaluation in the original 45,000 acres shows eradication is being achieved. The inclusion of this additional 215,000 acres in 1979 is to determine if we have the operational capability to handle the logistics of a large-scale effort which would be necessary if the decision is made to eradicate this pest from the United States.

The population suppression technology for the trial eradication program utilizes the integration of chemical, biological, and cultural control measures. These methods, when applied in the designated manner, progressively reduce the population within the area until extinction.

The program consists of the following suppression components:

Preprogram Practices

1. Voluntary inseason and reproduction-diapause control program by growers.
2. Information and education.

First Year of Program

1. Inseason control (all Arthropod pests)
2. Grandlure traps
3. Reproduction-diapause control and defoliation
4. Regulatory activities

Second Year of Program

1. Grandlure traps

2. Trap crops baited with grandlure

3. Release of sterile boll weevils

4. Spot treatment of incipient infestations as needed

5. Regulatory activities

Third and Final Year of Program

1. Grandlure traps

2. Trap crops where needed

3. Release of sterile weevils on approximately 25 percent of the acreage.

4. Spot treatment of incipient infestations if needed.

5. Regulatory activities.

Appendix F gives a more detailed breakdown of the operations and the sequence in which each component will be applied during the 3-year period.

The effectiveness of each individual suppression component is dependent on the effectiveness of the preceding one. Therefore, each component is important in achieving eradication and each must be applied to every cottonfield in the area.

It is desirable and expected that cotton producers will carry out a voluntary reproduction-diapause control program in the fall preceding

the first year of the program to reduce the diapausing population and thus delay the need for inseason control the following season.

Inseason control with insecticides will be utilized as the initial phase of the program to reduce weevil populations to low levels and thereby enhance the effectiveness of reproduction-diapause control. The use of precisely timed insecticide treatments is the most effective method for reducing high boll weevil populations (110). If high late-summer populations are allowed to develop, the effectiveness of reproduction-diapause control will be reduced (15, 91).

Inseason insecticide treatments for boll weevil will be made in compliance with the recommendations of the State research and extension agencies. Boll weevil population surveys will be made at weekly intervals during the season to effectively time, execute, and evaluate the necessary treatments. Based on the weevil's biology and the normal population density in the program area, a maximum of seven inseason control treatments will be required. These will be made at 5-day intervals beginning in late June and continuing until late July when populations reach the levels at which treatment is recommended by State authorities.

Azinphosmethyl or malathion will be applied as ultra-low-volume sprays with fixed-wing aircraft at the rate of 0.25 lb/acre or 1.21 lbs/acre, respectively. A thorough review of insecticides for boll weevil control shows that both of these chemicals give effective control when applied according to label directions (81).

Spot insecticide treatments of incipient infestations in the second and third year of the program will be made with ground application equipment supplemented with aerial treatment as needed.

Reproduction-diapause control treatments will be utilized to reduce boll weevil populations in the field before they can attain firm diapause necessary for winter survival. The reproduction-diapause control technique has been shown to be highly effective and will reduce the population by 99 percent or more when properly applied (11, 18, 87, 104). Azinphosmethyl at 0.25 lb/acre or malathion at 1.21 lbs/acre will be applied at ultra-low-volume sprays on 5 to 10 day intervals beginning about August and continuing until frost. A maximum of 11 treatments will be required. Treatments will be applied with fixed-wing aircraft and supplemented with ground application equipment in difficult to treat areas. The first year of the program 100 percent of the acreage will be treated, while the second year only about 25 percent is expected to require treatment. Reproduction-diapause treatments are not anticipated for the third and final year of the program.

In the first year of the program control of other Arthropod pests of cotton that reach economically damaging levels will be the responsibility of program personnel. Other pest control required in subsequent years will be the producers responsibility.

In order to prevent buildup of _Heliothis_ spp. populations, three applications of chlorodimform at 0.125 lb/acre will be made on 5-day intervals from about August 1 to 15. This is the peak period of _Heliothis_ spp.

activity in Virginia, North Carolina, and South Carolina and populations can usually be held below the economic level with this control method (17). However, if other insecticides are required for control of Heliothis spp. or other Arthropod pests, those recommended in the Cooperative Extension Service "Cotton Insect Control Guide" will be utilized. All pesticides will be applied in accordance with the label and regulations of the respective State departments of agriculture.

All cotton in the eradication program area will receive an application of defoliant (Def or Folex) in the fall of the first year to reduce the available food supply to weevils attaining diapause. This treatment will be made with fixed-wing aircraft from mid- to late September depending on when cotton reaches the recommended stage of maturity. Def or Folex at 1.125 lbs/acre will be applied in water for a total mix of 5 gals/acre.

Beginning in the spring of the first year, Leggett traps (76) will be operated around each field at an average rate of one trap/acre during the growing and harvest seasons for survey and population suppression. Traps for survey only will be operated at an average of one/10 acres during the remainder of the year. The traps will be baited and serviced twice monthly with the synthetic pheromone of the boll weevil (107), grandlure (55). Each bait will consist of 10 mg. of grandlure impregnated on a cigarette filter (90) and contained in a glass vial (22) or a mylar[R] plastic coated cardboard cylinder (43) to allow the proper release rate.

The use of grandlure traps is an important component of the program because: (1) They are essential for population assessment, survey, and detection (53); (2) They capture a high percentage of the population during the early emergence period before cotton begins to fruit, thus providing population suppression (16, 53, 54, 85). Trap efficiency in capturing boll weevils at low population densities is near 80 to 90 percent. As the population density increases, trap efficiency decreases (54, 85). This relationship brings out the importance of reducing weevil populations to low numbers during the preceding season.

Grandlure-baited trap crops have been shown to be effective in aggregating overwintered boll weevils for population reduction with spot chemical treatments (43, 50, 86, 103). Most boll weevil populations develop and spread from "hot spots" located near field borders adjacent to hibernation sites.

Trap crops or aggregation areas, consisting of selected areas of cotton near the field borders and adjacent to boll weevil hibernation sites, will be created and maintained in every cottonfield from mid-May to mid-July during the second year of the program. In the third year, trap crops will be used only in fields where infestations were detected the preceding season. The area utilized as a trap crop will consist of not more than 1 to 3 percent of the total acreage. Grandlure, in the most effective formulation, will be dropped into the trap crops at 200-foot intervals to attract emerging overwintered weevils. Drops will be made at weekly intervals for 8 weeks. Azinphosmethyl or malathion will be

applied on 5-day intervals with ground application equipment to kill weevils drawn to the trap crop.

Aerial distribution of sterile boll weevils is the final phase of the eradication program. This action is designed to prevent aggregation and reproduction of the few weevils that may have survived other control measures. Sterile weevils will be released over all fields during the second year and over approximately 25 percent the third year. This would include fields where infestations are detected the second year and buffer areas adjacent to infested cotton outside of the eradication zone. Sterile weevils will be released at the rate of 100 weevils/acre/week from mid-May through August. This rate will provide an effective overflooding ratio when native populations are at the anticipated low densities.

Weevils for release will be of the ebony strain and mass reared in the laboratory by an automated system (49, 78). Sterility will be achieved by exposure of the weevils to 60 CO radiation. The use of the ebony strain will allow for easy and quick identification of sterile insects introduced into fields.

As with the use of grandlure in traps and trap crops, the effectiveness of sterile releases is inversely related to the density of the native population. Again this exemplifies that each of the suppression components is equally important and necessary. The pilot eradication experiment was perhaps the most valid test ever given to the sterile release principle (80). Although effective suppression has been obtained in

previous tests (38, 39), the results in some cases have been obscured by migration into the test area. In the southern two-thirds of the eradication zone of the pilot experiment, excellent suppression by sterile insects was obtained. This area had at least 25 miles isolation from outside populations and native weevils had been reduced to very low numbers.

The sterile weevils were responsible for 98.5 to 100 percent sterility of eggs laid by native females during the last 5 weeks in this area of the experiment (80). Extensive surveys detected only one larva during this period (which accounted for the 98.5 percent).

In additon to the population suppression components, certain regulatory activities will be necessary to insure success of this program. The necessary regulatory activities for the trial program area are as follows:

1. Quarantine authority to quarantine the area under treatment and/or the areas cleared of boll weevils.
2. Access and entry authority.
3. Authority to require the reporting of all cotton acreage planted to insure that all acreage is included in the program.
4. Authority to execute the program on 100 percent of the cotton acreage.
5. Authority to purchase and destroy cotton which may pose an undue hazard to program success because of difficulty in executing the program components.
6. Authority to prohibit planting of noncommercial cotton in the eradication area.

7. Authority to take the necessary action to prevent volunteer cotton and alternate host plants from jeopardizing program success.

Statutory Basis for Conduct of Program

The Secretary of Agriculture, through enabling authorities granted the U.S. Department of Agriculture by Congress, may either independently or in cooperation with States concerned or political subdivisions, farmers, associations, and similar organizations and individuals, carry out operations to eradicate, suppress, control, or to prevent or retard the spread of insect pests, plant diseases, and nematodes. The authorities for the trial boll weevil eradication program are covered by the following acts:

> Organic Act of the Department of Agriculture (Act of September 21, 1944, as amended; Title 7, United States Code, Section 147a).
>
> Cooperation with State Agencies in Administration and Enforcement of Certain Federal Laws, (Act of September 28, 1962; Title 7, United States Code, Section 450).
>
> Agriculture and Consumer Protection Act, (Act of August 10, 1973; Public Law 93-86, United States Code, Section 611).

Each State has basic pest control authority permitting participation in cooperative pest control programs.

Research and Methods Development

As a result of the intensified research effort carried out since the early 1960's by Federal, State, and industry research agencies, substantial progress has been made in developing more effective boll weevil population suppression technology. The application of various phases of this technology by cotton producers across the Belt has provided

increasingly more effective and economical boll weevil control. The integrated application of this technology in a Federal/State/industry cooperative program, and the Pilot Boll Weevil Eradication Experiment has also provided a sound approach to boll weevil eradication. Although the technology has evolved to a sophisticated level, its application on an operational scale will undoubtedly disclose unforeseen and unpredictable problems that will require ongoing research and development as the program progresses. Thus, it is essential that this trial program be adequately supported by a strong applied research and development effort. This is necessary not only to deal with unanticipated problems that may arise, but also to continually improve technology to achieve a more economically sound and effective program.

The following is a general breakdown of the research, development, and monitoring effort that will be conducted by the U.S. Department of Agriculture, State universities, experiment stations, and industry in direct support of the trial eradication program:

1. Continue to search for effective suppression methods which attack the basic biological system of the insect having a minimal impact on nontarget organisms.
2. Evaluate and perfect, for operational use, promising suppression methods or technical advances that would contribute to increased efficiency or cost reduction.
3. Continue work to refine, for optimum use, existing suppression technology.
4. Monitor boll weevil populations to detect any evidence of resistance to insecticides used in the program.

5. Monitor the various program components to determine the effects on nontarget and beneficial organisms.
6. Monitor and evaluate impact of eradication of boll weevil on other organisms during and after eradication.
7. Continued research in preparation for expanding into other areas of the Cotton Belt if the trial program is successful as follows:
    a. Continue biological and ecological studies in all areas of the Belt with special regard to diapause, hibernation, and emergency patterns.
    b. Determine the possibility of boll weevil survival in noncotton-growing areas in Florida.
    c. Determine size and types of barrier zones and their cost required to prevent reentry of the boll weevil into each eradication zone, and to prevent reentry from Mexico.
    d. Develop boll weevil eradication models for the different ecological areas.

During this trial eradication program, the U.S. Department of Agriculture and State agricultural experiment stations will continue to conduct research and development studies on biology, ecology, and chemical and nonchemical methods of population suppression. The main objective of these studies is to continue to develop more effective, more economical, and safer methods of control, management, or eradication having minimal adverse effects on the environment.

The Animal and Plant Health Inspection Service, Methods Development Staff is conducting field evaluations on (1) refined operational methods for using grandlure in trap crops, (2) monitoring for grandlure in animals and birds frequenting cottonfields, (3) developing improved methods and aerial equipment for releasing sterile boll weevils and grandlure, (4) determining if grandlure can be used to concentrate boll weevils in restricted hibernation sites for treatment, and (5) evaluating alternate insecticide formulations and rates for diapause boll weevil control.

Results to date from the trap crop studies show that the use of aerially dropped grandlure plus foliar insecticide treatments on 1 to 3 percent of the farmer's cotton provides substantial suppression of the boll weevil population. Effective procedures and equipment have been developed for the aerial release and distribution of sterile weevils and grandlure.

The Agricultural Research Service and the State agricultural experiment stations are conducting a broad-based research program on the biology, ecology, physiology, mass rearing and sterilization, and control of the boll weevil. This includes both chemical and nonchemical methods such as host plant resistance, pathogens, pheromones, and parasites. The current major research objectives are in the following areas:

1. Further mechanize and automate mass rearing operations to produce boll weevils with maximum vigor at a minimum cost. A significant recent development is the identification of the

microbial contamination problem which lowered production and produced low-vigor weevils. Improved methods for control of contamination of eggs and weevils is sought and will result in more eggs laid per female, greater egg hatch, and the production of a more vigorous weevil.

2. Refine methods of mass sterilization that continue to be logistically and ecologically acceptable that will provide permanent sterility in both sexes. Results of recent laboratory tests show that dipping and fumigation with chemosterilants, fractionation of gamma-rays or perhaps a combination of these procedures may prove more effective and more economical than any single technique. It has also been discovered that females can be completely sterilized by immersing them in a Thompson-Hayward 6040 (1-(4-chlorophenyl)-3-(2, 6-difluorobenzoyl) - area growth regulator. This compound is transferred from males to females during mating and has potential for direct application as a spray in a field.

3. Refine and seek new methods of formulation and use of grandlure and traps for survey, detection, and suppression of boll weevil populations. The infield trap (93), recently developed at the Boll Weevil Research Laboratory, shows considerable promise for detection of low population densities and for suppression of overwintered and subsequent field generations. Also, new formulations of grandlure have an effective field life of 4 to 8 weeks.

4. Develop safe, effective, selective, and ecologically acceptable control methods. Effective insecticides are being tested alone and in combination with other suppression methods. Further studies are being done with frego bract cotton which shows a high degree of resistance to the weevil. Also a pathogen-bait formulation resulted in control equal to that of insecticides during early and late season but requires considerable research on formulation and application.
5. Determine the biology of the boll weevil in various areas of its range. Biological studies are being conducted in various areas in relation to overwintering survival, population dynamics, incidence of diapause, migration, importance of alternate hosts, and response to grandlure by various strains of the weevil.

II. ENVIRONMENTAL IMPACTS

The application of all the suppression components utilized in the program, including the insecticide and defoliant treatments, will be done by trained personnel under the direction of highly trained and experienced supervisors. All pilots and aircraft used for aerial application of pesticides will meet the requirements of the Federal Aviation Administration and State Regulatory Agencies. Direction and precautions on the labels of all chemicals will be followed precisely. Pesticides will be applied only to cottonfields. Close attention will be given to the equipment and climatic conditions in order to prevent undue drift

and to prevent contamination of ponds, wells, streams, and nontarget crops or plants. Protective measures will be taken to prevent exposure of humans and domestic animals to the pesticides.

The pesticides which may be used for boll weevil control include:

Insecticides:
1. Malathion
2. Azinphosmethyl (Guthion)
3. Chlorodimform (Galecron and Fundal)

Defoliants:
1. Def
2. Folex

The insecticides will be applied by contract aircraft as ultra-low-volume sprays at the following rates per acre: malathion, 1.25 lbs.; azinphosmethyl, 0.25 lb.; chlorodimform, 0.125 lb. The defoliant will be applied at 1.125 lbs/acre in a diluted mixture with 5 gallons of water. Supplemental treatments of insecticides and defoliants may be made with ground application equipment in areas difficult to treat with aircraft or which may present a hazard to the environment. All of the chemicals to be used are labeled for use on cotton and have been used extensively by growers in all parts of the Cotton Belt. When used in accordance with the label, they have been acceptable from a safety and health standpoint (6). Therefore, significant damage to wildlife and other nontarget organisms is not expected. The overall impact of using these materials in the 3-year eradication program should be less than that of the farmer's insect control program carried out over an equivalent time period. Table 1 gives a comparison of the average number of pesticide treatments that will be applied in the trial eradication program and the number normally applied by the farmers in the area. Only in the first year of the program will more (28 percent) pesticide

treatments be used than in the farmer's usual boll weevil control program. In the second and third year, there will be a 68 percent and a 97 percent reduction, respectively in the number of insecticide treatments normally applied by the farmer. In the fourth and subsequent years, insecticide treatments will be required only to control outbreaks of other cotton pests such as bollworms, plant bugs, fleahoppers, etc., when populations of these pests overwhelm natural control forces.

Other program components to be utilized in the trial program include the use of the boll weevil pheromone, grandlure. The synthetic pheromone (107, 108), grandlure, acts as a boll weevil aggregation and sex attractant. Grandlure is a naturally occurring compound which is produced as a windborne pheromone by the male boll weevil (34, 71). Grandlure is formulated with glycerol, water, polyethylene glycol, and mathanol and impregnated on a cigarette filter wick at the rate of 10 mg/filter (55). The treated filter is inserted in a small glass vial or a mylar[R] coated cardboard cylinder for placement in traps. At an average rate of one trap per acre in operation for 13 weeks, 71.5 mg. of grandlure per acre will be used in traps each year of the program. At 2-week intervals, the traps will be serviced. The old wicks and containers will be taken to the laboratory for destruction. An average of approximately 176 mg. and 44 mg. of grandlure per acre of cotton will be used in trap crops during the second and third years of the program, respectively. The grandlure in these traps will not be collected for destruction.

III. SUMMARY OF PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

It has been recognized for many years that insecticide treatments have varying effects on parasites, predators, and other nontarget arthropods in cottonfields (44, 45, 75, 79). Monitoring studies on the effects of malathion and azinphosmethyl applied for reproduction-diapause control on the Texas High Plains showed that some beneficial insects and other nontarget organisms are affected, but that such effects that do occur are of limited duration (63, 64, 65, 66, 67). Applications of either malathion or azinphosmethyl resulted in an immediate reduction in populations of certain beneficial arthropods in cotton, but these reductions were not carried over to the subsequent crop year. Nontarget predator populations inhabiting noncultivated land surrounding nontarget cottonfields did not differ from populations in areas adjoining fields treated with malathion or azinphosmethyl.

Other studies showed the effects of fall insecticide treatments for control of boll weevil on larval populations of *Heliothis* spp. on cotton (12, 13). *Heliothis* spp. larval populations increased rapidly soon after reproduction-diapause treatments began with both azinphosmethyl and malathion. However, population densities the following season were approximately equal in cotton treated in the fall to cotton that had not been treated.

The Entomology Department, Mississippi Agricultural and Forestry Experiment Station, conducted an intensive monitoring study to measure the impact of the pilot boll weevil eradication experiment on nontarget

insects in cotton as compared to an adjacent "normal" cotton-growing area (where growers applied insect control treatments) (56). In general, the results of this 3-year study show that during the period when intensive insecticide treatments were applied in the eradication area (1972), predator populations were lower and *Heliothis* spp. populations were higher than in the "normal" growing area. In the last year of the pilot experiment (1973) when very little insecticide was applied, the situation completely reversed, which further supports the statement that in the absence of insecticides for boll weevil control the natural enemies of *Heliothis* spp. will often regulate population fluctuations within levels considerably below that justifying insecticide treatment for control. It was also observed that in the eradication area where no insecticides were applied, tarnished plant bug and cotton fleahopper populations, although never reaching high population densities, were almost double that observed in the "normal" insecticide treated growing area.

Ultra-low-volume malathion and azinphosmethyl have been reported toxic to bees (24, 58, 70, 77). No differences in bee kill were found with malathion or azinphosmethyl in the pilot eradication experiment in 1971 (112). Bee mortality in the eradication area in 1972 where azinphosmethyl, Def, and Folex were applied was lower than in the "normal" cotton-growing area where toxaphene-DDT-methyl parathion combinations were commonly used by growers (56). These results indicate that honeybees are less affected by the organophosphate pesticides that will be used in the trial boll weevil eradication program than by the organochlorine-organophosphate mixtures used in "normal" cotton insect control programs.

It is the policy of the U.S. Department of Agriculture to notify beekeepers of the time and place of malathion applications and, if necessary, give assistance in protecting bees from exposure to pesticides.

In monitoring studies on wildlife in Michigan on the cereal leaf beetle program, and on fish and wildlife in Nebraska on grasshopper control, it was found that technical malathion at the rate of 0.64 pounds per acre did not adversely effect terrestrial and aquatic wildlife (10, 102).

To determine the effect of malathion on wild bobwhite quail, captured quail were sprayed seven times with malathion at 1 pound per acre in cottonfields in west Texas and fed treated feed in between field treatments (51). There were no discernable detrimental effects on the quail as a result of these treatments.

The effects of malathion and azinphosmethyl on quail, migratory birds, and nongame birds were studied on the Rolling Plains of Texas for 5 years (40).

Periodic checks of habitat adjacent to malathion and azinphosmethyl-treated fields failed to reveal any detrimental effects on quail or other birdlife from the aerial applications of either of these insecticides. Ingestion of feed treated with malathion and azinphosmethyl by caged quail caused no deaths or apparent illness. It was concluded that while azinphosmethyl applied at the rate of 0.25 pounds per acre is more toxic than malathion applied at 1.21 pounds per acre, it does not adversely affect quail or other birds more than malathion.

The Department of Wildlife and Fisheries, Mississippi State University, conducted a monitoring program to determine the effects of the Pilot Boll Weevil Eradication Experiment on various wildlife species inhabiting cottonfields (101). Bobwhite quail chicks, Coturnix quail chicks, and Fowler's toads were exposed (in cottonfields) to normal field applications of malathion, azinphosmethyl, and Def with no adverse effects. No mortality occurred as a result of the pesticide treatments which were applied at the same rate that will be used in the trial eradication program.

Folex was fed to 1-week-old Pekin ducklings and bobwhite quail for 5 days at levels ranging from 215 to 21,500 ppm. (42). The 8-day LC_{50} for the ducklings was 12,500 ppm and 1850 ppm for quail. Studies to compare the susceptibility of mallard and Pekin ducklings shows both species to be comparable.

The toxicity of azinphosmethyl and malathion to fish varies considerably between species, but in general azinphosmethyl is more toxic than malathion (96). A study on the effects of ultra-low-volume malathion on fish and aquatic invertebrates as applied in the Texas High Plains diapause boll weevil control program was conducted in 1965 (8). Results from the application of 1.21 pounds of technical malathion per acre showed no adverse affects on (1) caged largemouth bass and bluegill, (2) resident populations of largemouth bass, bluegill, channel catfish, and various forage fish, (3) zooplankton populations, and (4) bottom sediment fauna. In a Texas experiment, aerial applications of azinphosmethyl to shallow farm ponds using rates of 3 and 4 ounces AI/A caused

serious mortality of largemouth bass and redear sunfish. Green sunfish, channel catfish, black bullheads, and cyprinids were not affected (61).

There is no knowledge of field monitoring studies on the affects of chloridimform, Def, or Folex on fish and other aquatic organisms. These materials are used by growers in their cotton production programs and no adverse affects on the environment have come to our attention as a result of their use. It is anticipated that the use of these pesticides in this program will have little if any measurable impact on aquatic organisms since applications are made only to cottonfields. Application will not be made over ponds, lakes, or streams and necessary precautions will be taken to prevent drift onto these areas.

Coturnix quail chicks fed 10, 15, or 20 busulfan sterilized boll weevils per day for 3 weeks showed no change in physical condition or growth rate and no mortality was observed in any of the treatments (74). These treatments had no effect on the reproductive performance of the parental or the F_1 generations. Also nestling redwing blackbirds (3-5 days old) fed 5-15 sterilized boll weevils per day in the nest survived to flight stage with no apparent adverse effects (101). No adverse effects were anticipated since most of the busulfan is metabolized by the weevils within 24 hours postingestion (113).

Laboratory studies with grandlure show that the oral LD_{50} in mice is in excess of 680 mg/kg and dermal LD_{50} in rabbits is in excess of 500 mg/kg

(59). The 96-hour LC_{50} for bluegill sunfish is 44 ppm. (59). A preliminary field monitoring study on this material is presently underway in west Texas by the Animal and Plant Health Inspection Service, but results are not available at this time.

IV RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY.

The relationship between short-term and long-term uses and maintenance will be shown by an economic analysis comparing current boll weevil control with a boll weevil pest management program and with the proposed trial eradication program. The area of consideration is confined to the cotton acreage in Virginia, North Carolina, and South Carolina.

For the purpose of this analysis, benefits were taken as the difference in the value of cotton production, while costs were taken as the cost of insecticides, their application, and other direct production costs associated with the execution of the proposed program. No attempt was made to estimate the social benefits from executing alternative boll weevil control programs.

The yields of cotton lint and seed and their farm value for these areas are averages derived from 1970, 1971, 1972, and 1973 statistics furnished by the Statistical Reporting Service of USDA. The existing yield losses and cost of boll weevil control were taken from a 1974 survey titled, "Boll Weevil Losses: Value and Location of Losses Caused by the Boll Weevil, Beltwide and State Cost Summaries Estimated by the National

Cotton Council in Cooperation with State Extension Specialist" (5). The value of cotton production with "no chemical control" was estimated from data taken from this 1974 survey.

The value of cotton production under a pest management program was estimated by assuming yield losses would be one-half the existing yield losses (present control) to the boll weevil. The value of cotton production and the benefits for the four alternative programs (Eradication, Pest Management, Present Control, and No Chemical) are presented in Table 2. The cost of existing control is presented in Table 3.

The annual cost of carrying out a pest management program was estimated according to the values and assumptions presented in Table 4. The basic assumptions being that only four applications of insecticide (versus the present 10 to 15) would be needed for boll weevil control and that the cost per acre would be less owing to economy of scale (contracting for large acreage with application by aircraft) and the lowering of the amount of insecticide used per acre (from the present 1 to 1-1/2 lbs/acre to 1/2 lb/acre). In addition to control costs, scouting at $1.50/acre and regulatory measures at $1.00/acre were included as cost of carrying out a pest management program. To reflect grower apathy resulting from low weevil populations, and for other reasons, it was assumed that an average of 85 percent of the cotton acreage would be in the pest management program in any given year. The remaining 15 percent would continue the existing strategy of repeated applications of insecticides to the growing cotton plant.

The total cost of eradicating the boll weevil was estimated from detailed per acre or annual costing of the various program functions. The eradication trial is scheduled for 3 years duration, the amount of time required to complete all program operations on the initial 45,000 acres. However, in order to estimate the cost of eradication on the entire area including the second increment, which would be picked up in subsequent years, it was necessary to extrapolate the budget estimate over a 4-year period. This would then reflect the completion of the eradication program over the entire area and better distribute certain fixed costs. Any decision as to actual execution of this additional work would await evaluation of the 3-year trial. The total cost was then prorated according to cotton acreage in each of the three States (Table 5).

The annual value of benefits (totals for the three States and as per acre) are summarized in Table 6. These values are presented with a no-chemical control program as the base line. For example, annual benefits for the entire area (67,879,000) were obtained by subtracting value of cotton in a no-chemical program (24,345,000) from total value of cotton with eradication (92,224,000) in Table 2. In interpreting these benefits, it should be kept in mind that 3 years will be required to achieve eradication in a given area and that it would probably require 5 or more years to achieve an effective pest management program. Furthermore, pest management requires a continuing input of public and private monies to remain effective and thus to achieve the benefits,

whereas eradication requires no additional resource inputs other than regulatory action to prevent reinfestation. It should be pointed out that the values used in estimation of pest management costs and benefits are based upon our best estimates. This approach has never been executed on a large contiguous area and these estimates may prove to be overly optimistic insofar as benefits and costs are concerned.

There is reason for concern among cotton producers and scientists that the present control measures (existing insecticides) may be lost in the near future through development of pest resistance or regulatory action. This would result in the value of cotton production falling from an average of \$164.47 per acre to \$50.32 per acre as a result of man's inability to control the boll weevil with insecticides. The loss of insecticides, therefore, is the basis for using "no chemical" as the base line in estimating benefits. Table 6 is arranged to facilitate all possible comparisons. For example, the annual benefits of eradication over no chemicals for North Carolina total \$24.779 million, while pest management over no chemical total \$21.714 million. The marginal or additional benefits of eradication over pest management is, therefore, \$24.779-\$21.714=\$3.965 million. The marginal benefits of pest management over present control for North Carolina total \$21.714- \$18.650=\$3.064 million.

Three-year cumulative benefits and costs for the alternative programs are presented in Table 7. The 3-year cumulative totals were selected because it is the number of years required to achieve eradication.

Table 7 is also arranged to facilitate comparison. For example, the 3-year cost of eradication over present control totals \$29.597 million for the three States. The 3-year cost of pest management over present control is \$-19.761 million, indicating that present control would cost more than pest management. Net benefits are benefits minus cost. Thus, the net benefits of pest management over present control total \$18.993-(\$-19.761)= \$38.694 million. The net benefits of eradication over pest management totals \$-30.359 million (=\$18.999-\$49.358), where \$18.999= \$203.637-184.638 and \$49.358=\$69.923-\$20.565 during the 3-year period of achieving eradication. It is important to note that after 3 years, the benefits of eradication would continue to accrue forever at an annual rate of \$26.13 per acre in increased value of production and \$27.78 per acre in reduced control cost (for pest management program) or at \$53.91 per acre forever for every acre of cotton grown.

Benefits and costs for the four alternative courses of action are given in Table 8 in which the base line for comparison is the present method of control. These values are for the 3-year period required to complete eradication in a given area. These same values are presented graphically in Figure 3 to project the relative values over a 30-year period. A comparison of costs and benefits for the four alternatives projected over a 10-year period is given in Table 9.

It should be pointed out that the costs of eradication presented herein are higher than projected costs per acre for a beltwide program. This higher cost results from the fact that certain fixed and startup costs cannot be spread over the greater number of years required for total

eradication. Also, a smaller unit area and personnel training costs will run costs higher in program startup. It is further expected that greater efficiency in program execution will evolve as the program proceeds. Also, the trial site is located in one of the most difficult cotton-growing areas to execute the eradication program, with lesser costs expected in much of the Cotton Belt from the midsouth to the west.

V IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

All research and program monitoring results to date have shown that the local population of a few nontarget organisms are temporarily affected. There is no evidence that significant irreversible or irretrievable commitments of resources will occur. In fact, eradication of the boll weevil, an introduced species, should tend to restore the original ecological balance between other cotton pests and their natural enemies.

VI ALTERNATIVES TO THE PROPOSED ACTION

The alternatives currently available are:

(1) To organize and execute an areawide integrated pest management program based on the control of diapausing boll weevils. This technique, supplemented with the boll weevil pheromone, grandlure, could be integrated into production practices improving the individual producer control strategy. The requirements for a high degree of success in a program of this type, however, come very close to the requirements for an areawide eradication program. Furthermore, such a program would year after year be dependent to a very large extent on insecticides applied during the key periods of the season.

(2) The least desirable alternative is for growers to continue the present program of applying insecticides throughout the growing season. This approach has the obvious disadvantages of high production costs and continuing environmental hazards. Serious problems could be created if resistant strains of *Heliothis* spp. continue to develop throughout the Cotton Belt. Furthermore, the boll weevil might develop resistance to the organophosphates as it did to the organochlorines in the mid-1950's. This would essentially eliminate cotton production in the boll weevil belt. Also, if this happens there are no alternate methods for preventing the westward movement of the weevil onto the High Plains of Texas and into the cotton areas of New Mexico, Arizona, and California.

It seems obvious that the eradication of this key pest of cotton is the best solution to cotton pest control. In a management program with boll weevil present, it would be necessary to use chemicals to reduce diapause populations each year. This key action in management would require an organized effort to insure areawide population suppression. In effect, the management program will be much more complex and require greater organizational effort with the boll weevil than in its absence.

If the boll weevil can be eliminated as a factor, the pest management program will be much simpler and less expensive to achieve. It is true that initial costs are greater for eradication than pest management; but, the long-range benefits are much greater for eradication, both for economic and environmental considerations.

Another fear often expressed in relation to eradication is the possibility that the intensive selection pressure of the diapause control phase of the program would result in organophosphate resistance in the boll weevil. This is unlikely for two reasons: (1) For the last 20 years boll weevil populations in the Midsouth are subjected to the same type suppression from intensive treatment at rates 2-3 times greater than required for weevil control in control operations for the Heliothis complex. The weevil is practically eliminated from large areas by these treatments, and no evidence or resistance has been found to date. (2) Another factor against phosphate resistance is the fact that cleanup measures for the very low populations during the second and third years of operations will be with pheromone and sterile insects. These measures will not exert a selection pressure for insecticide resistance. Yet, a year-after-year diapause program as a part of pest management will continue to select for resistance to the chemicals used.

VII CONSULTATION WITH APPROPRIATE FEDERAL AGENCIES AND REVIEW BY STATE AND LOCAL AGENCIES DEVELOPING AND ENFORCING ENVIRONMENTAL STANDARDS AND PUBLIC INVOLVEMENT

On February 13-15, 1974, public conferences were held in Memphis, Tennessee, on Research on Boll Weevil Suppression and Elimination Technology (Conf. I) and Boll Weevil Management and Elimination Strategies (Conf. II). The research conference was sponsored by the U.S. Department of Agriculture, State agricultural experiment stations, cooperative extension services, and State departments of agriculture of the Southern Region. The management and elimination conference was sponsored by the

National Cotton Council of America. The purpose of Conference I was to have a public disclosure of the development of boll weevil suppression technology and the results of the Pilot Boll Weevil Eradication Experiment. Conferees attended from all of the organizations listed above as well as other interested parties such as cotton growers. Detailed results of the pilot experiment were presented and discussed. A paper was presented by Dr. L. D. Newsom of Louisiana State University giving a critical analysis of the boll weevil elimination concept and the alternate strategies, which in his opinion should be utilized instead of eradication (19). Also the overall plan for a national boll weevil elimination program drawn up by the National Cotton Council Technical Subcommittee was presented and discussed (47).

Various scientists in the Animal and Plant Health Inspection Service, Agricultural Research Service, and State agricultural experiment stations, and cooperative extension services were consulted in the preparation of this statement. The information obtained from these groups was incorporated into the appropriate sections.

Copies of the draft environmental statement were sent to the agencies or individuals listed in Appendix J for review. Comments received are also given in Appendix J. Their comments were used in the revision of the draft to produce this environmental statement.

SELECTED REFERENCES

1. Anonymous. 1969. Selection of Locations for Pilot Boll Weevil Eradication Experiments. A Report of the Findings of a Subcommittee Appointed by the National Cotton Councils' Special Study Committee on Boll Weevil Eradication. August 15.

2. Anonymous. 1971. Environmental Statement. Pilot Boll Weevil Eradication Experiment. USDA - APHIS - PPQ, Washington, D.C. 20250. August 2. 14 pp plus attachments.

3. Anonymous. 1972. Environmental Statement. Cooperative Boll Weevil Diapause Control Program. USDA - APHIS - PPQ. ADM-72-4. April 25.

4. Anonymous. 1973. Overall Plan for a National Program to Eliminate the Boll Weevil from the United States. A Report of the National Cotton Council of America Technical Subcommittee on Boll Weevil Eradication. December 4. 72 pp.

5. Anonymous. 1974. Boll Weevil Losses: Value and Location of Losses Caused by the Boll Weevil. Beltwide and State Cost Summaries. The National Cotton Council in Cooperation with State Extension Specialists. June. 52 pp.

6. Anonymous. 1974. 27th Annual Conference Report on Cotton Insect Research and Control. Memphis, Tennessee.

7. Ahrnad, M. and H. R. Burk. 1972. Larvae of the weevil tribe Anthonomii. Misc. Publ. Entomol. Soc. of Am. 8: 32-81.

8. Anderson, L. D. and E. L. Atkins, Jr. 1958. Toxicity of pesticides and other agricultural chemicals to honey bees, in laboratory and field tests in Southern California, 1955-1956. J. Econ. Entomol. 51: 103-8.

9. Beal, F. E. I., W. L. McAtee, and E. R. Kalmbach. 1918. Common birds of the southeastern United States in relation to agriculture. Farmer's Bull. 755:4.

10. Black, C. T., and G. L. Zorb. 1965. Cereal leaf beetle control and wildlife in Michigan, Part II, 1964. Mich. Dept. Conserv. June. 10 pp.

11. Bottrell, D. G., and L. K. Almond. 1968. Evaluation of the 1967 reproductive-diapause boll weevil control program of the Texas High Plains. Tex. Agr. Exp. Sta. MP-904. 4 pp.

12. Bottrell, D.G., and L. K. Almond. 1969. The effects of reproductive-diapause boll weevil control programs on populations of the bollworm and tobacco budworm in cotton. 1968. Texas Agr. Exp. Sta. Progr. Rep. 2702.

13. Bottrell, D. G., D. M. Arnold, and L. K. Almond. 1968. Effects of reproductive-diapause boll weevil insecticidal control programs on the abundance of bollworms and tobacco budworms in cotton in the rolling plains of Texas. 1967. Texas Agr. Exp. Sta. Progr. Rep. 2627.

14. Boyd, F. J. 1947a. The Pilot Boll Weevil Eradication Experiment, 1971-73: Operational plan and execution. Proc. Conf. on Research on Boll Weevil Suppression and Elimination Technology. February 13-14. Memphis, Tennessee. (In press)

15. Boyd, F. J. 1947b. The Pilot Boll Weevil Eradication Experiment, 1971-73. Inseason and reproduction-diapause control. Proc. Conf. on Research on Boll Weevil Suppression and Elimination Technology. February 13-14, Memphis, Tennessee. (In press)

16. Boyd, F. J., Jr., J. R. Brazzel, W. F. Helms, R. J. Moritz, and R. R. Edwards. 1973. Spring destruction of overwintered boll weevils in West Texas with wing traps. J. Econ. Entomol. 66: 507-10.

17. Bradley, J. R. 1974. Personal communication. North Carolina State Agr. Exp. Sta., Raleigh, N.C.

18. Brazzel, J. R. 1959. The effect of late-season applications of insecticides on diapausing boll weevils. J. Econ. Entomol. 52: 1042-45.

19. Brazzel. J. R. 1974. A plan for beltwide elimination. Proc. Conf. on Boll Weevil Management and Elimination Strategies. February 15. Memphis, Tennessee. (In press)

20. Brazzel, J. R., T. B. Davich, and L. D. Harris. 1961. A new approach to boll weevil control. J. Econ. Entomol. 54(4): 723-30.

21. Brazzel, J. R. and L. D. Newsom. 1959. Diapause in *Anthonomus grandis* Boh. J. Econ. Entomol. 52: 603-11.

22. Bull, D. L., J. R. Coppedge, D. D. Hardee, D. R. Rummel, G. H. McKibben, and V. S. House. 1973. Formulations for controlling the release of the synthetic pheromone (grandlure) of the boll weevil. 3. Laboratory and field evaluation of three slow-release preparations. Environ. Entomol. 2: 905-9.

23. Burgess, E. P. 1965. Control of the boll weevil with technical malathion applied by aircraft. J. Econ. Entomol. 58: 414-15.

24. Campbell, L. S. 1968. Principal effects of aerial application of Guthion to farm ponds. Job Completion Report. State of Texas Parks and Wildlife Dept. Austin, Texas.

25. Chesnut, Thomas L., and William H. Cross. 1971. Arthropod parasites of the boll weevil, Anthonomus grandis: 2. Comparisons of their importance in the United States over a period of thirty-eight years. Ann. Entomol. Soc. Amer. 64: 549-557.

26. Cleveland, T. C., W. P. Scott, T. B. Davich, and C. R. Parencia, Jr. 1966. Control of the boll weevil on cotton with ultra-low-volume (undiluted) technical malathion. J. Econ. Entomol. 59: 973-6.

27. Coad, B. R. 1915. Recent studies of the Mexican cotton boll weevil. USDA Dept. Bull. 231.

28. Cross, W. H. 1974. Movement and Dispersal of Boll Weevils. Proc. Conf. on Research on Boll Weevil Suppression and Elimination Technology. February 13-14. Memphis, Tennessee. (In press)

29. Cross, W. H. 1974. Personal communication. USDA, ARS, Boll Weevil Research Laboratory, Mississippi State, Mississippi.

30. Cross, William H., and Thomas L. Chesnut. 1971. Arthropod parasites of the boll weevil, Anthonomus grandis: 1. An annotated list. J. Econ. Entomol. 64: 516-527.

31. Cross, W. H., and D. D. Hardee. 1968. Traps for survey of overwintered boll weevil populations. USDA Cooperative Economic Insect Report. 18: 430.

32. Cross, W. H., D. D. Hardee, F. Nichols, H. C. Mitchell, E. B. Mitchell, P. M. Huddleston, and J. R. Tumlinson. 1969. Attraction of female boll weevils to traps baited with males or extracts of males. J. Econ. Entomol. 62: 154-61.

33. Cross, W. H., M. J. Lukefahr, P. A. Fryxell, and H. R. Burke. 1974. Host Plants of the Boll Weevil. J. Entomol. Soc. Am. (In press)

34. Cross, W. H. and H. C. Mitchell. 1966. Mating behavior of the boll weevil. J. Econ. Entomol. 59: 1503-7.

35. Cushman, R. A. 1911. Studies in the biology of the boll weevil in the Mississippi Delta region of Louisiana. J. Econ. Entomol. 4: 432-3.

36. Dameshek, W., H. B. Granville, and F. Rubio. 1958. Therapy of the myeloproliferative disorders with myleran. Ann. N. Y. Acad. Sci. 68: 1001.

37. Davich, T. B., D. D. Hardee, and Jesus Alcala M. 1970. Long-range dispersal of boll weevils determined with wing traps baited with males. J. Econ. Entomol. 63: 1706-8.

38. Davich, T. B., J. C. Keller, E. B. Mitchell, P. Huddleston, R. Hill, D. A. Linquist, G. McKibben, and W. H. Cross. 1965. Preliminary field experiments with sterile males for eradication of the boll weevil. J. Econ. Entomol. 58: 127-31.

39. Davich, T. B., M. E. Merkl, E. B. Mitchell, D. D. Hardee, R. T. Gast, G. H. McKibben, and P. A. Huddleston. 1967. Field experiments with sterile males for eradication of the boll weevil. J. Econ. Entomol. 60: 1533-38.

40. Davis, B. D. 1969. Dynamics of bobwhite quail in the West Texas rolling plains. Job No. 7. Effect on quail, migratory birds and nongame birds from aerial application of malathion and other insecticides. Unpublished Job. Prog. Rep., State of Texas Parks and Wildlife Dept., Austin, Texas. 12 pp.

41. Debord, D. 1974. Importance of cotton. National Cotton Council of America. Unpublished Mimeo. Rep. 3 pp, 4 tables.

42. Dieterich, W. H. 1965. Folex: Acute dietry administration to Pekin ducks and bobwhite quail. Unpublished report. Hazleton Laboratories, Inc. December 1, 6 pp.

43. Edwards, R. R., A. Higgins, F. J. Boyd, R. J. Moritz, J. R. Brazzel and J. C. Hatchett. 1974. Evaluation of trap crops and different trap crop treatments for suppression of boll weevil populations. J. Econ. Entomol. (In preparation).

44. Ewing, K. P. and E. E. Ivy. 1943. Some factors influencing bollworm populations and damage. J. Econ. Entomol. 36: 602-6.

45. Falcon, L. A., R. van den Bosch, C. F. Ferris, L. K. Stromberg, L. D. Etzel, R. E. Stinner, and T. F. Leight. 1968. A comparison of season-long pest control programs in California during 1966. J. Econ. Entomol. 61: 633-42.

46. Fenton, F. A., and E. W. Dunnam. 1929. Biology of the cotton boll weevil at Florence, S.C. USDA Tech. Bull. 112.

47. Fischer, P., Jr. 1966. Effects of aircraft applications of malathion on fish and aquatic invertebrates. Federal Aid Project No. F-17-R-1. Job Completion Report. January 24. 14 pp.

48. Gaines, J. C. 1951. Beneficial insects' role in cotton insect control. Acco Press. p. 22-24.

49. Gast, R. T. and T. B. Davich. 1966. Boll Weevils: In Insect Colonization and Mass Production. New York Academic Press. pp. 406-18.

50. Gilliand, F. R. 1974. The Pilot Boll Weevil Eradication Experiment, 1971-73: Trap Crops. Proc. Conf. on Research on Boll Weevil Suppression and Elimination Technology. February 13-14. Memphis, Tennessee. (In press)

51. Green, H. W. 1967. Dynamics of bobwhite quail in the West Texas rolling plains. State of Texas Parks and Wildlife Dept. Job completion report for Federal Aid Project No. W-88-R-6. pp. 1-6.

52. Grossman, E. F. 1929. Control of the cotton boll weevil by insect enemies. Science 69: 362.

53. Hardee, D. D. and F. J. Boyd. 1974. The Pilot Boll Weevil Eradication Experiment, 1971-73: Trapping. Proc. Conf. on Research on Boll Weevil Suppression and Elimination Technology. February 13-14. Memphis, Tennessee.

54. Hardee, D. D., O. H. Lindig, and T. B. Davich. 1971. Suppression of populations of boll weevils over a large area in West Texas with pheromone traps in 1969. J. Econ. Entomol. 64: 928-33.

55. Hardee, D. D., G. H. McKibben, R. C. Gueldner, E. B. Mitchell, J. H. Tumlinson, and W. H. Cross. 1972. Boll weevils in nature respond to grandlure, a synthetic pheromone. J. Econ. Entomol. 65: 97-100.

56. Harris, F. A., K. K. Shaunak, C. A. Wilson, G. A. Hurst, and C. L. Simmons. 1974. The Pilot Boll Weevil Eradication Experiment, 1971-73: Effects on nontarget species. Proc. Conf. on Research on Boll Weevil Suppression and Elimination Technology. (In Press)

57. Haynes, J., and N. Mitlin. Unpublished data. USDA, ARS, Boll Weevil Research Laboratory, Mississippi State, Mississippi. 39762.

58. Hitchcock, J. D., J. R. Elliott, and D. A. George. 1966. Effects on honey bees of aerial application of technical malathion. Amer. Bee. J. 106: 294-5.

59. Hopkins, A. R., H. M. Taft, and W. James. 1969. Life history of the boll weevil in field cages. J. Econ. Entomol. 62: 964-65.

60. Howard, L. A. 1894. A New Cotton Insect in Texas. USDA Div. Entomology, Insect Life 7: 273.

61. Howard, D. J., W. B. Knott, and G. Woodard. 1972. Safety evaluation of grandlure. Unpublished report. Woodard Research Corp. Herndon, Virginia 22070. 25 pp.

62. Howe, R. W. 1916. Studies of the Mexican cotton boll weevil in the Mississippi Valley. USDA Dept. Bull. 358.

63. Huddleston, E. W., D. Ashdown, and D. C. Herzog. 1966. A comparison of the effects of the 1964 and 1965 High Plains boll weevil control program on population trends of nontarget arthropods. Agr. Ind. Entomol. Rep. No. 66-1, Texas Tech. Coll. 20 pp.

64. Huddleston, E. W., D. Ashdown, and T. M. Hills. 1967a. A comparison of the effects of the 1964, 1965, and 1966 High Plains boll weevil control program on population trends of nontarget arthropods. Agr. Ind. Entomol. Rep. No. 66-1, Texas Tech. Coll. 14 pp.

65. Huddleston, E. W., D. Ashdown, and T. M. Hills. 1967b. Spring population trends of nontarget insects following the third year of the High Plains boll weevil control program. Agr. Ind. Entomol. Rep. No. 67-2 (Supplemental). Texas Tech. Coll. 11 pp.

66. Huddleston, E. W., C. W. O'Brien, C. R. Ward, and D. Ashdown. 1972. Use of population indices to monitor the effect of the High Plains boll weevil control program on nontarget arthropods. Agr. Ind. Entomol. Rep. No. 72-1. Texas Tech. Univ. 48 pp.

67. Huddleston, E. W., C. R. Ward, and J. L. Pulley. 1968. Spring population trends of nontarget insects following the fourth year of the High Plains boll weevil control program. Agr. Ind. Entomol. Rep. (not numbered) Texas Tech. Coll. 12 pp.

68. Hunter, W. D. 1910. The status of the boll weevil in 1909. USDA Bur. Entomol. Circ. 122. 12 p.

69. Hunter, W. D. and B. R. Coad. 1922. The boll weevil problem. USDA Farmers' Bulletin 1262. 21 pp.

70. Johansen, C. A., M. D. Levin, J. D. Eves, W. R. Forsyth, H. B. Busdicker, D. S. Jackson, and L. I. Butler. 1965. Bee poisoning hazard of undiluted malathion applied to alfalfa in bloom. Wash. Agr. Exp. Sta. Wash. State Univ. Circ. 455. 10 pp.

71. Keller, J. C., E. B. Mitchell, G. McKibben, and T. B. Davich. 1964. A sex attractant for female boll weevils from males. J. Econ. Entomol. 57: 609-10.

72. Klassen, W. and N. W. Earle. 1970. Permanent sterility induced in boll weevils with busulfan without reducing production of pheromone. J. Econ. Entomol. 63: 1195-98.

73. Knipling, E. F. 1974. The Pilot Boll Weevil Eradication Experiment: Report of Technical Guidance Committee. Proc. Conf. on Research on Boll Weevil Suppression and Elimination Technology. February 13-14. Memphis, Tennessee. (In press)

74. Kulkarni, P. G., Norman Mitlin, and G. H. Hurst. 1973. Toxicity of busulfan and influence of ingested chemosterilized boll weevils on reproduction performance of the Japanese quail. J. Econ. Entomol. 66: 341-3.

75. Laster, Marion L. and J. R. Brazzel. 1968. A comparison of predator populations in cotton under different control programs in Mississippi. J. Econ. Entomol. 61: 714-19.

76. Leggett, J. E., and W. H. Cross. 1971. A new trap for capturing boll weevils. USDA Cooperative Economic Insect Report 21: 773-74.

77. Levin, M. D., W. R. Forsyth, G. L. Fairbrother, and F. B. Skinner. 1968. Impact on colonies of honey bees of ultra-low-volume (undiluted) malathion applied for control grasshopper. J. Econ. Entomol. 61: 58-62.

78. Lindig, O. H. 1974. Development of Boll Weevil Suppression and Elimination Technologies: Mass Rearing. Proc. Conf. on Research on Boll Weevil Suppression and Elimination Technology. February 13-14. Memphis, Tennessee. (In press)

79. Lingren, P. D., R. L. Ridgway, C. B. Cowan, Jr., J. W. Davis, and W. C. Watkins. 1968. Biological control of the bollworm and tobacco budworm by arthropod predators affected by insecticides. J. Econ. Entomol. 61: 1521-5.

80. Lloyd, E. P. 1974. The Pilot Boll Weevil Eradication Experiment, 1971-73: Sterile males. Proc. Conf. on Research on Boll Weevil Suppression and Elimination Technology. February 13-14, Memphis, Tennessee. (In press)

81. Lloyd, E. P. and D. G. Bottrell. 1974. Insecticides for use in beltwide eradication of the boll weevil. Unpublished Special Report. 21 pp.

82. Lloyd, E. P., M. L. Laster, and M. E. Merkl. 1964. A field study of diapause, diapause control, and population dynamics of the boll weevil. J. Econ. Entomol. 57: 433-7.

83. Lloyd, E. P., J. R. McCoy, W. P. Scott, E. C. Burt, D. B. Smith, and F. C. Tingle. 1972. Inseason control of the boll weevil with ultra-low-volume sprays of azinphosmethyl and malathion. J. Econ. Entomol. 65: 1153-6.

84. Lloyd, E. P., J. L. McMeans, and M. E. Merkl. 1961. Preferred feeding and egg-laying sites of the boll weevil and the effect of weevil damage on the cotton plant. J. Econ. Entomol. 54: 979-984.

85. Lloyd, E. P., M. E. Merkl, F. C. Tingle, W. P. Scott, D. D. Hardee, and T. B. Davich. 1972. Evaluation of male-baited traps for control of boll weevils following a reproduction-diapause program in Monroe County, Mississippi. J. Econ. Entomol. 65: 552-55.

86. Lloyd, E. P., W. P. Scott, K. K. Schaunah, F. C. Tingle, and T. B. Davich. 1972. A modified trapping system for suppressing low density populations of overwintered boll weevils. J. Econ. Entomol. 65: 1144-47.

87. Lloyd, E. P., F. C. Tingle, J. R. McCoy, and T. B. Davich. 1966. The reproduction-diapause approach to population control of the boll weevil. J. Econ. Entomol. 59: 813-6.

88. Lloyd, E. P., F. C. Tingle, M. E. Merkl, E. C. Burt, D. B. Smith, and T. B. Davich. 1967. Comparison of three rates of application of ultra-low-volume azinphosmethyl in a reproduction-diapause program against the boll weevil. J. Econ. Entomol. 60: 1696-9.

89. Marlott, C. L. 1933. Report of the Chief of the Bureau of Entomology. USDA, Washington, D.C. 47 p.

90. McKibben, G. H. 1972. A device for injecting grandlure into cigarette filters. J. Econ. Entomol. 65: 1509-10.

91. Meeks, R. A., Jr., E. P. Lloyd, R. C. Robinson, and M. E. Merkl. 1966. A large-scale field evaluation of boll weevil diapause control in Mississippi. J. Econ. Entomol. 59: 811-13.

92. Miller, J. H., and G. F. Crisfield. 1930. The presence in Georgia of *Bracon mellitor* Say, a parasite of the cotton boll weevil. J. Econ. Entomol. 23: 607-8.

93. Mitchell, E. B. and D. D. Hardee. 1974. In-field traps; A new concept in survey and suppression of low populations of boll weevils. J. Econ. Entomol. (In press)

94. Newsom, L. D. The boll weevil problem in relation to other cotton insects. 1962. Proceedings of the Boll Weevil Symposium, State College, Mississippi, March 21. p. 83-91.

95. Newsom, L. D. 1970. The end of an era and future prospects for insect control. Tall Timbers Conf. Ecol. Anim. Contr. Habitat Manage. Tallahassee, FL. Feb. 26-28. 2: 117-36.

96. Newsom, L. D. 1974. The elimination concept and its alternatives. Proc. Conf. on Boll Weevil Management and Elimination Strategies. February 15. Memphis, Tennessee. (In press)

97. Newsom, L. D. and J. R. Brazzel. 1968. Pests and their control. In: Advances in Production and Utilization of Quality Cotton: Principles and Practices. The Iowa State University Press, Ames, Iowa. pp. 367-405.

98. Newsom, L. D. and C. E. Smith. 1949. Destruction of certain insect predators by applications of insecticides to control cotton pests. J. Econ. Entomol. 42: 904-8.

99. Newsom, L. D. 1974. The elimination concept and its alternatives. Proc. Conf. on Boll Weevil Management and Elimination Strategies. February 15. Memphis, Tennessee. (In press)

100. Pierce, W. D., R. A. Cushman, and C. E. Hood. 1912. The insect enemies of the cotton boll weevil. USDA Bur. Entomol. Bull. 100. 99 p.

101. Roach, E. R. 1973. The effects of the boll weevil eradication experiment on certain wildlife species. M.S. Thesis. Dept. of Wildlife and Fish., Mississippi State University. 54 pp.

102. Robertson, K., B. Schoenecker, and L. C. McEwen. 1965. The effects of the 1964 grasshopper control program in Sioux County, Nebraska. U.S. Plant Pest Control Div. February. 11 pp.

103. Roussel, J. S. and D. F. Clower. 1957. Resistance to the chlorinated hydrocarbon insecticides in the boll weevil. J. Econ. Entomol. 50: 463-8.

104. Rummel, D. R., and P. L. Adkisson. 1971. A two-phased control program designed for maximum suppression of the boll weevil in the High and Rolling Plains of Texas. J. Econ. Entomol. 64: 919-22.

105. Scott, W. P., E. P. Lloyd, J. O. Bryson, and T. B. Davich. 1974. Trap plots for suppression of low density overwintered populations of boll weevils. J. Econ. Entomol. 67: 281-3.

106. Smith, G. L. 1936. Percentages and causes of mortality of boll weevil stages within the squares. J. Econ. Entomol. 29: 99-105.

107. Sterling, W. L. and P. L. Adkisson. 1971. Seasonal biology of the boll weevil in the High and Rolling Plains of Texas as compared with previous biological studies on this insect. Tex. Agr. Exp. Sta. MP-993. 12 pp.

108. Tumlinson, J. H., R. C. Gueldner, D. D. Hardee, A. C. Thompson, P. A. Hedin, and J. P. Minyard. 1971. Identification and synthesis for the four compounds comprising the boll weevil sex attractant. J. Org. Chem. 36: 2616-21.

109. Tumlinson, J. H., D. D. Hardee, R. C. Gueldner, A. C. Thompson, P. A. Hedin, and J. P. Minyard. 1969. Sex pheromones produced by male boll weevils: Isolation, identification, and synthesis. Science 166: 1010-12.

110. Whitcomb, W. H. 1970. History of integrated control as practiced in the cottonfields of the South-Central United States. Tall Timbers Conf. Ecol. Anim. Contr. Habitat. Manage. Tallahassee, FL. Feb. 26-28. 2: 147-155.

111. Whitcomb, W. H., and K. Bell. 1964. Predaceous insects, spiders, and mites of Arkansas cottonfields. Ark. Agri. Expt. Sta. Bull. 690: 8-9.

112. Wilson, C. A. and C. L. Simmons. 1972. Results, honey bee, monitoring South Mississippi boll weevil eradication experiment. Mimeographed report. 1 p.

113. Wiygul, G., N. Mitlin, and A. C. Thompson. 1971. Metabolism of busulfan in the boll weevil. Pesticide Biochem. Physiol. 1: 418-423.

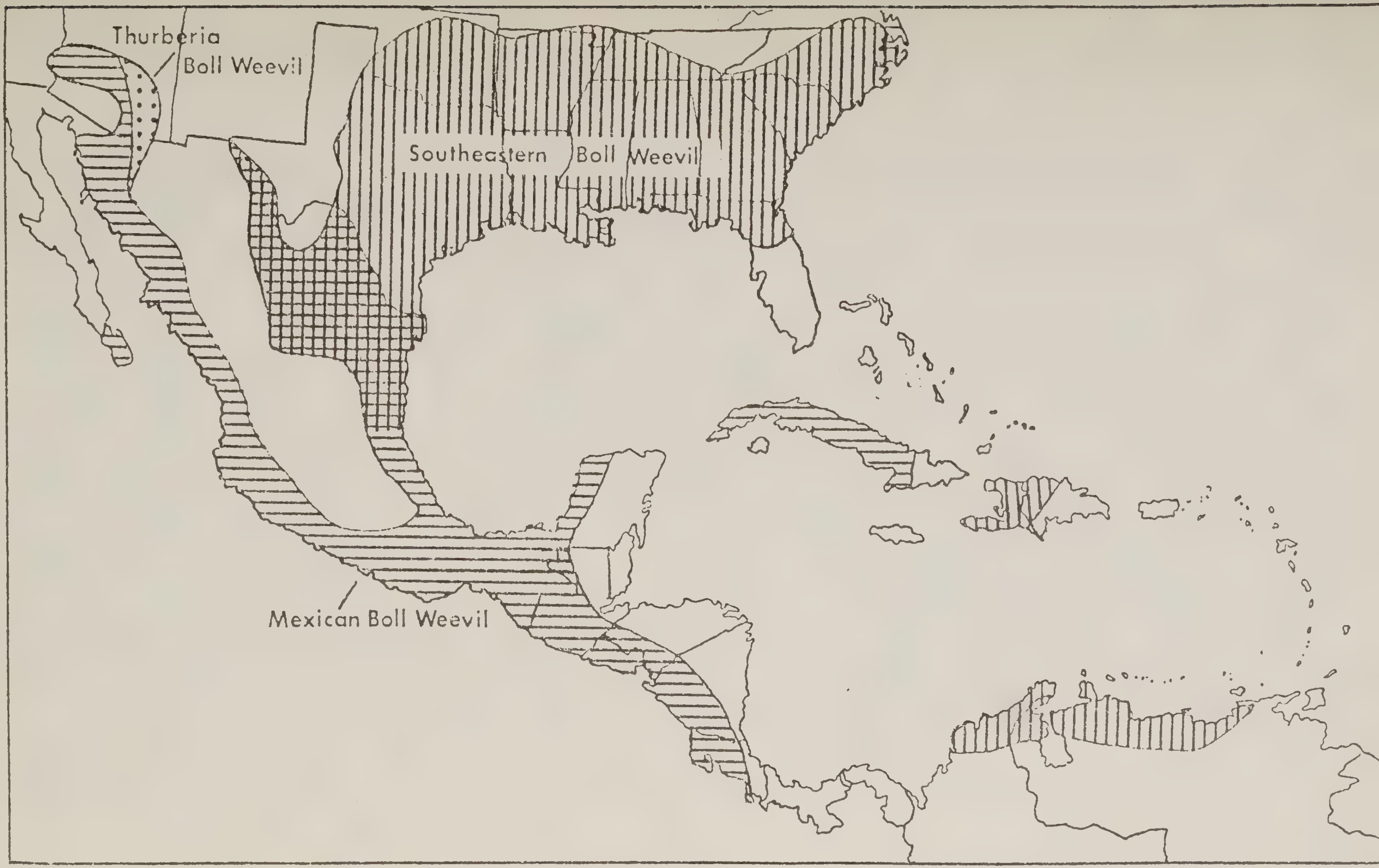


Figure 1. Distribution of the boll weevil.

Figure 2. Cotton Acreage Planted in Virginia, North Carolina, and South Carolina 1973 by Counties. The trial will be initiated on approximately 100,000 acres of cotton located within the concentric circles.

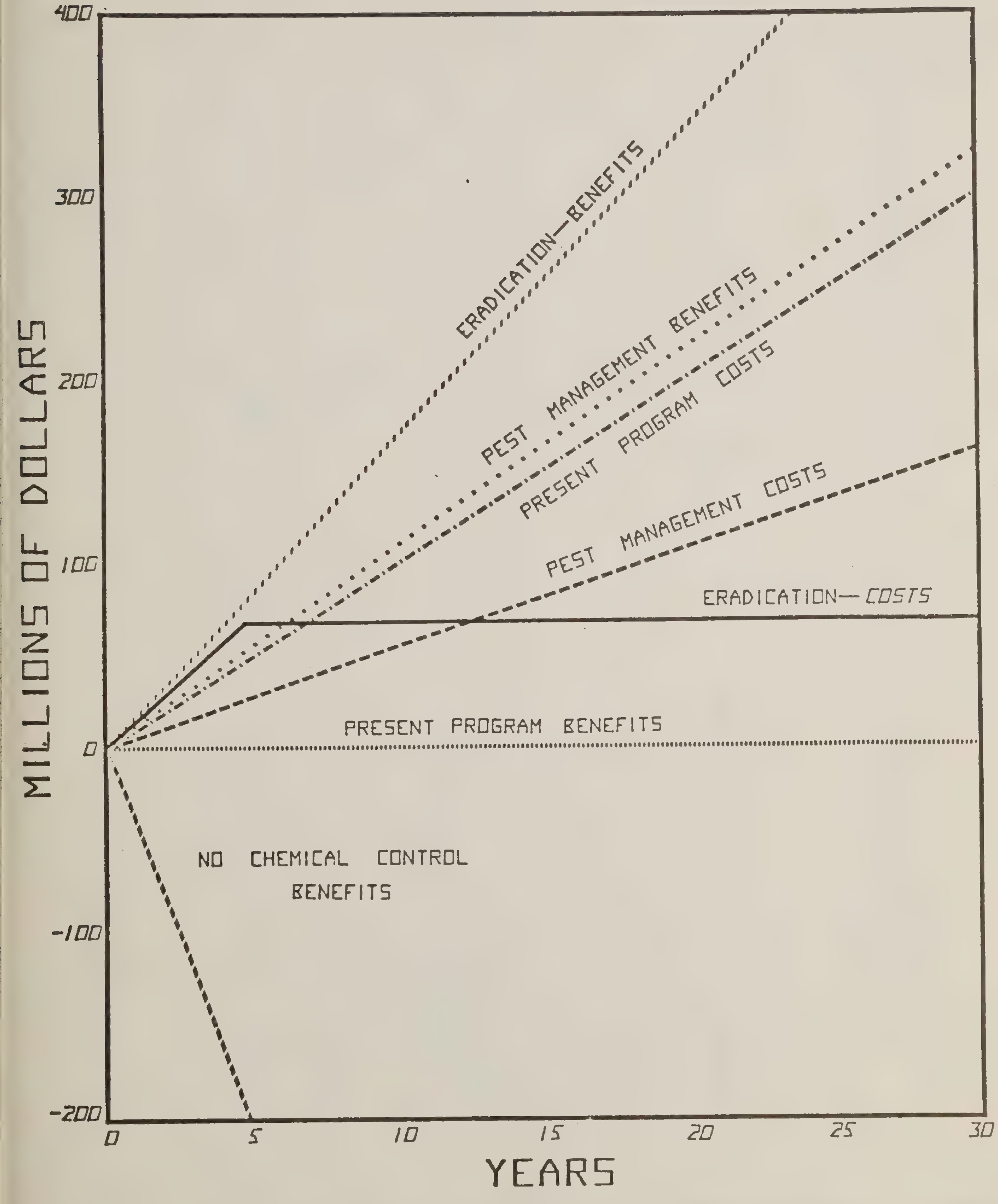


FIGURE 3. *RELATIVE COSTS AND BENEFITS OF FOUR ALTERNATIVE COURSES OF ACTION FOR BOLL WEEVIL CONTROL WITH PRESENT CONTROL PROGRAM AS THE BASE LINE.*

Table 1. A comparison of the number of insecticide treatments that will be applied in the trial eradication program and the number normally used for boll weevil control by the farmer in the Virginia-North Carolina-South Carolina area.

	Number of Applications by Year							
	1st year		2nd year		3rd year		4th year	
Activity	Program	Farmer	Program	Farmer	Program	Farmer	Program	Farmer
Inseason control	7	11	1 1/	11	0.1 1/	11	0	11
Diapause control	11	1	3 1/	1	0.3 1/	1	0	1
Trap crop	-	-	0.15	-	0.03 1/	-	0	-
Total	18	12	4.15	12	0.43	12	0	12

1/ Spot treatments when needed--expected to be mostly near the edge of the eradication zone adjacent to outside infestations.

Table 2

VALUE OF COTTON PRODUCTION UNDER ALTERNATIVE BOLL WEEVIL CONTROL SYSTEMS 1/

Program & Location	Harvested Acres	Percent Loss to Boll Weevil	Value of Production: Total (000)	Value of Production: Per Acre
North Carolina	169,500			
Eradication		0.00	$34,704	$204.74
Pest Management		8.83	31,639	186.66
Present Control		17.66	28,575	168.58
No Chemical		71.40	9,925	58.56
South Carolina	311,000			
Eradication		0.00	$57,003	$183.29
Pest Management		5.60	53,814	173.03
Present Control		11.19	50,624	162.78
No Chemical		75.00	14,251	45.82
Virginia	3,348			
Eradication		0.00	$517	$154.42
Pest Management		13.02	438	130.90
Present Control		26.27	381	113.86
No Chemical		67.28	169	50.37
Total	483,848			
Eradication		0.00	$92,224	$190.61
Pest Management		7.10	85,891	177.52
Present Control		13.71	79,580	164.47
No Chemical		73.60	24,345	50.32

1/ Acreage and value of production taken from 1970-1973 (inclusive) averages obtained from Statistical Reporting Services. Price does not include subsidy payments. Loss (percentages) are from 1974 survey--Boll Weevil Losses; conducted by the National Cotton Council in conjunction with State extension specialists except for Virginia where values were extrapolated from adjacent areas in North Carolina.

Table 3. Annual control cost (insecticide and application) of existing boll weevil control.

State	Acres (70-73)	Cost/acre 1/	Total for State
North Carolina	169,500	$21.81	$ 3,696,795
South Carolina	311,000	31.10	9,672,100
Virginia	3,348	21.81	73,020
TOTAL	483,848		$13,441,915

1/ From survey conducted by the National Cotton Council in cooperation with State extension specialist in 1974.

Table 4. Control and operating cost of pest management program

Control Costs

State	(70-73) Acres	Number Applications	Cost per Application	Total
North Carolina	144,075 -----	4 ----	$1.50 ---	$ 864,450
South Carolina	264,350 -----	4 ----	$1.50 ---	2,586,100
Virginia	2,846 -----	4 ----	$1.50 ---	17,070
	411,271			$2,467,620
Nonparticipating 1/	72,577		27.98 2/	$2.030,704
	483,848			$4,498,324

Operating Costs

State	Acres	Regulatory $/acre	Scouting	Research Development	Total
North Carolina	169,500 ---	$1.00 ---	$1.50 --	$ 65,800 --	$ 489,550
South Carolina	311,000 ---	1.00 ----	$1.50 --	65,800 --	843,300
Virginia	3,348 ---	1.00 ---	$1.50 --	16,450 --	24,820
	483,848			$148,050	$1,357,670

Total Cost of Pest Management Program

Control	$4,498,324	
Regulatory & scouting	$1,357,670	
	$5,855,994	$12.10/acre

1/ Assumes 85 percent of acreage will come into a pest management program. This reflects apathy of growers when boll weevils become scarce and they relax the necessary control for themost effective pest management program. The remaining 15 percent will continue protection at existing control costs.

2/ Average existing cost per acre for these States obtained from survey conducted by the National Cotton Council in cooperation with State extension specialists in 1974.

Table 5. Estimated Cost of Eradicating the Boll Weevil from North Carolina, South Carolina, and Virginia 1/.

State	(70-73) Acreage	Cost/Acre	(000) Total for State
North Carolina	169,500	$144.51	$24,495
South Carolina	311,000	144.51	44,944
Virginia	3,348	144.51	484
	483,848	$144.51	$69,923 1/

1/ This value is for the projected cost of execution of the complete eradication program over the entire area in order to accurately present costs per acre. The proposed trial program will be on a lesser scale.

Table 6.

Benefits From Executing Alternative Boll Weevil Programs

Program & Location	Annual Benefits of Program at Left over No Chemical	over Present Control	over Pest Management	Per Acre Benefits of Program at Left over No Chemical	over Present Control	over Pest Management
		(000)				
North Carolina						
Eradication	$24,779	$6,129	$3,065	$146.19	$36.16	$18.08
Pest Management	21,714	3,064	-	128.11	18.08	-
Present Control	18,650	-		110.03	-	
No Chemical	-			-		
South Carolina						
Eradication	$42,752	$6,379	$3,189	$137.47	$20.51	$10.25
Pest Management	39,563	3,190	-	127.21	10.26	-
Present Control	36,373	-		116.95	-	
No Chemical	-			-		
Virginia						
Eradication	$348	$136	$79	$103.94	$40.62	$23.60
Pest Management	269	57	-	80.35	17.03	-
Present Control	212	-		63.32	-	
No Chemical	-			-		
Total						
Eradication	$67,879	$12,644	$6,333	$140.29	$26.13	$13.09
Pest Management	61,546	6,311	-	127.20	13.04	-
Present Control	55,235	-		114.16	-	
No Chemical	-			-		

Table 7.

Three-Year Cumulative Benefits and Costs of Alternative Boll Weevil Programs

	Benefits of Program at Left			Costs of Program at Left			Net Benefits		
	Over No Chemical	Over Present Control	Over Pest Management	Over No Chemical	Over Present Control	Over Pest Management	Over No Chemical	Over Present Control	Over Pest Management
Total									
Eradication	203,637	37,932	18,999	69,923	29,597	49,358	133,714	8,335	-30,359 1/
Pest Management	184,638	18,933	0	20,565	-19,761	0	164,073	38,694	0
Present Control	165,705	0		40,326	0		125,379	0	
No Control	0			0			0		

1/ This value is for the 3-year period of actual eradication operations. Continuing imputs would be needed for pest management, but none for eradication except routine regulatory measures.

Table 8. Benefits and costs for four alternative courses of action which accrue from direct loss to boll weevil and cost of control over a 3-year period compared with present control program.

Course of Action	Benefits (x1000)	Costs 1/ (x1000)
1. Eradication	69,258	69,923 3/
2. Pest Management	32,691	17,568 4/
3. Present Control 2/	0	31,326
4. Loss of Effective Chemical	-165,705	cultural practices

1/ Losses plus cost of control
2/ Base for comparisons
3/ One-time costs, none in post-program period
4/ This cost is reoccurring indefinitely

Table 9. Comparison of costs and benefits of boll weevil eradication program, pest management, current pest control, and no pest control efforts.

Item	Costs or returns after 1/			
	1 year 2/	3 years	5 years	10 years
	Million dollars			
Eradication:				
Benefits	92.2	276.6	461.0	922.0
Costs	23.3	69.9	69.9	69.9
Net return	68.9	206.7	391.1	852.1
Pest Management:				
Benefits	85.9	257.7	429.5	859.0
Costs	6.9	20.6	34.5	69.0
Net return	80.0	237.1	384.0	790.0
Present Control:				
Benefits	79.6	238.8	398.0	796.0
Costs	13.4	40.3	67.0	134.0
Net return	66.2	198.5	331.0	662.0
No Control:				
Benefits	24.3	72.9	121.5	243.0
Costs	0	0	0	0
Net return	24.3	72.9	121.5	243.0
Net Benefit of Eradication over				
Pest management	-10.1	-30.4	7.1	62.1
Present control	2.7	8.2	60.1	190.1
No control	44.6	133.8	269.6	609.1

1/ Based on data in the "Draft Environmental Statement for Trial Boll Weevil Eradication Program."
2/ Annual cost of the 3-year program.
3/ This table is taken from the comments on the draft EI statement by T. Eichers of the Economic Research Service, USDA.

APPENDIX A

IMPORTANCE OF COTTON

Cotton in this nation represents a sizable investment in land and equipment; it provides millions of jobs; and the industry is a major consumer of goods. These are economic contributions which are quickly measured, but there are other sides of the American economy in which cotton's impact, although maybe less obvious, is similarly important.

From the viewpoint of the consumer, cotton is significant because of the competition it generates in the fiber market. The prices of other fibers are held in check by cotton's presence and the research and development because of this competition result in better and lower-priced products. Many innovations seen in fabric construction and finishes began with work in cotton--durable press, for example.

Cotton is critical to maintaining a balanced agriculture. Divert a portion of cotton's 14 million acres to other crops and agriculture would be seriously disrupted. Repercussions would be felt nationally. Extra production in alternative crops would depress prices and reduce income.

The 1973 cotton crop required more than 14 million acres in 18 States to produce 13 million bales. This cotton was grown on 200,000 farms in a region stretching across the lower half of the United States from the Carolinas to California.

More than $11 billion is invested in land and equipment to grow cotton, with billions more invested in gins, oil mills, warehouses, textile plants, and merchandising establishments. A cost analysis showed that the 1973 cotton crop involved a production cost of about $2.6 billion. The major cost categories and amounts were: $636 million in power and equipment; $300 million in labor; $233 million in chemicals; $166 million in fertilizer; and $80 million in seed.

Cotton is one of agriculture's most important industrial crops. In 1973-1974, cotton and cottonseed provided $4.1 billion of revenue to farmers. This makes cotton the fourth leading crop in the United States, providing more than one-tenth as much revenue as all other crops combined.

Analyzing cotton's 1973 contribution to the agricultural economies of the 14 major cotton-producing states shows it to be the most important single field crop commodity in terms of revenue to the farmer (see Tables 1 and 2). Considering the crops of cotton, soybeans, corn, grain sorghum, barley, rye, oats, rice, wheat, peanuts, and tobacco, cotton lint and seed produced 46 percent more revenue than soybeans, 142 percent more than corn, 206 percent more than grain sorghum and 207 percent more than wheat. For the 14 state area, cotton provides 28 percent as much revenue as all other crops combined (excluding cotton) and 12 percent as much revenue as all other commodities combined (excluding cotton) (see Table 3).

One of the most important yardsticks for measuring the importance of an industry to the local and national economy is the employment it provides. Cotton is a major employer for workers in production, ginning, warehousing, transportation, cottonseed crushing, and many other industries providing goods and services to the industry.

Because production is heavily concentrated in relatively small locales best suited to its growth, cotton has an extremely heavy economic impact on many localized areas. It is estimated that more than 5 million persons live wholly or in very substantial part on incomes earned directly from cotton. This includes 1.3 million living on the farm, or who gin, store, and market the crop.

Additionally, the livelihoods of another 12 million employees and dependents are closely related to cotton. This group includes industries which are important users of cotton or which provide services and supplies to the cotton industry--such as financing, chemicals, machinery, and fuel.

Cotton is the leading raw material in textile and apparel manufacturing which employed 2.3 million persons with a payroll of $12.9 billion in 1972. Cotton consumption in the United States totaled 7.6 million bales during the 1973 calendar year. This was enough cotton for each person in the nation to consume 19 pounds of the fiber. Cotton is the number one textile fiber; holding 30 percent of the total market, 42 percent of the apparel market; 25 percent of the home furnishings market and 24 percent of the industrial use market.

Approximately 100 cottonseed oil mills process the 5 million tons of cottonseed to provide the nation with human food and animal feed. Cottonseed oil is an important vegetable oil used in margarine, shortening, and other consumer products. Cottonseed meal is a valuable high-protein livestock feed, while a new process to make cottonseed flour will provide a high-protein supplement to human diets. Another positive contribution of cotton production is that it helps provide mankind with a breathable atmosphere. Agricultural scientists estimate that each acre of cotton produces 16.5 tons of oxygen annually while removing 22.7 tons of carbon dioxide.

The above figures show that cotton is vital to the farming sector, to the agribusiness sector and to the textile industry. The factors affecting the cotton economy end up having a multiplied impact on the economy. It is a well-known fact that increased or decreased economic activity in a basic agricultural sector will have a multiplier effect on the rest of the economy--either up or down. A change in the production, marketing, processing or manufacturing situation will have repercussions throughout the cotton and related industries. This can be illustrated by an example showing the effects of an increase in the quantity of cotton demanded. One factor that could bring about this result is a lowering of

the price of cotton relative to competing fibers. This could occur by increased efficiency in the production, marketing or processing of cotton. The result of the larger demand for cotton would lead to a need to produce more cotton which would lead to an increase in the demand for the inputs into the production process. The producer would need more equipment, chemicals, fertilizer, more labor etc. The larger supply would require more inputs into the marketing and processing functions. This increased demand for inputs would cause an increased demand for the factors of production used to produce the basic inputs for cotton production, marketing, processing, etc. All of these activities create additional jobs and income and in effect keep the economic base of affected communities strong and viable.

Cotton is also important in foreign trade. The large net foreign exchange earnings of cotton are important to the economic health of the nation. Exports of U.S. agricultural products in fiscal year 1973-1974 amounted to a record $21.3 billion, up 65 percent from preceding fiscal year. The United States also imported $9.5 billion worth of agricultural products, leaving a net trade balance of 11.5 billion. Exports of cotton increased 73 percent in value to $1.3 billion.

Nonfarm trade produced a deficit of $9 billion and when the agricultural trade is added in, the deficit becomes a surplus of $2.5 billion. Cotton's contribution of $1.3 billion represents 48 percent of the overall net trade balance of $2.5 billion.

Table 4 shows the dollar value of exports, imports, and the net trade balance in cotton for the years 1963-1973.

Table 1

1973 CROP VALUES: VALUE OF PRODUCTION PLUS SUPPORT PAYMENT
(1,000 dollars)

STATE	Cotton	Soy-beans*	Corn	Grain Sorghum	Wheat	Rice*	Tobacco	Peanuts*	Barley	Oats*	Rye*
Ala.	149,243	106,260	80,050	2,465	5,793	---	768	64,000	---	814	---
Ark.	276,273	651,000	3,321	14,210	17,243	394,072	---	---	---	4,054	---
Ariz.	215,141	---	878	30,253	39,961	---	---	---	18,416	---	---
Calif.	560,071	---	75,930	57,973	103,768	259,659	---	---	117,602	6,468	---
Ga.	154,006	110,723	220,495	2,176	9,726	---	88,129	217,728	944	4,375	3,703
La.	143,842	220,590	7,947	2,122	1,258	288,819	135	---	---	361	---
Miss.	480,676	338,800	19,522	2,527	7,812	45,390	---	2,660	---	880	---
Mo.	57,004	710,640	603,363	72,227	84,356	3,503	3,395	---	1,465	1,743	403
N. Mex.	57,646	---	4,271	54,563	33,639	---	---	3,466	2,753	---	---
N. C.	64,996	201,600	286,139	10,468	19,005	---	717,180	77,432	4,555	4,125	479
Okla.	140,656	24,610	21,156	79,807	615,601	---	---	40,592	14,949	9,147	2,133
S. C.	106,185	134,188	64,737	1,171	8,641	---	115,282	5,082	1,590	3,427	1,163
Tenn.	124,622	201,078	99,061	3,666	13,911	---	89,440	---	789	1,392	74
Tex.	1,466,351	44,625	164,437	972,994	339,466	287,420	---	75,396	6,460	29,315	940
Totals	3,996,712	2,714,114	1,651,307	1,306,622	1,300,180	1,273,863	1,014,329	511,026	169,523	66,101	8,895

* Value of Production Only.

Sources: Field Crops: Production, Farm Use, Sales, Value 1972-1973. Crop Reporting Board, SRS, USDA, May 1974. Crop Production Crop Reporting Board, SRS, USDA, May 1974.

Table 2

RANKING OF COMMODITIES BY REVENUE IN 14 MAJOR COTTON PRODUCING STATES*

	Commodity	1973 Revenue ($ 1,000)	Ratio: Cotton Revenue / Commodity Revenue
1.	Cotton lint-seed	3,996,712	---
2.	Soybeans	2,744,114	1.46
3.	Corn	1,651,307	2.42
4.	Grain Sorghum	1,306,622	3.06
5.	Wheat	1,300,180	3.07
6.	Rice	1,278,863	3.13
7.	Tobacco	,014,329	3.94
8.	Peanuts	511,026	7.82
9.	Barley	169,523	23.57
10.	Oats	66,101	60.46
11.	Rye	8,895	449.32

* States: Alabama, Arkansas, Arizona, California, Georgia, Louisiana, Mississippi, Missouri, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas

Sources: Field Crops: Production, Farm Use, Sales, Value 1972-1973, Crop Reporting Board, SRS, USDA, May 1974.

Crop Production, Crop Reporting Board, SRS, USDA, May 1974.

Table 3

COTTON'S RELATIVE IMPORTANCE AS A SOURCE OF INCOME TO THE COTTON BELT STATES, 1972[a]

State	# Cotton Farms	Cotton[b] Revenue ($ millions)	All Crop Revenue ($ millions)	All Farm Revenue ($ millions)	Rank of Revenue From Cotton Relative To Other Crops	Revenue From Cotton as a % of Revenue From All Other Crops (not including cotton)
Ala.	25,633	134.280	371.460	987.854	1	57
Ark.	23,639	289.956	811.763	1,485.359	2	56
Ariz.	1,555	142.905	391.266	871.252	1	58
Calif.	5,439	352.446	3,390.715	5,596.499	4	12
Ga.	14,803*	92.816	715.456	1,502.230	2	15
La.	11,913	141.524	557.897	881.536	2	34
Miss.	31,868*	409.563	660.929	1,210.456	1	163
Mo.	10,176	88.792	852.002	2,089 847	3	12
N. C.	12,870*	39.034	1,074.357	1,716.729	3	4
Okla.	16,034*	65.331	417.351	1,499.074	2	19
S. C.	14,768	73.409	394.435	608.772	3	23
Tenn.	27,650*	111.610	393.040	907.829	1	40
Tex.	78,694	683.034	1,897.319	4,462.165	1	56
Total	275,042	2,624.700	11,927.990	23,819.602	1	28

a. Source: <u>Farm Income States Estimates, 1959-1972</u>, ERS-USDA, FIS222 SUPP/AUG 1973.

b. Revenue includes the cash receipts for lint and seed plus government payments.

* 1971 - Latest data available.

Table 4

COTTON FOREIGN TRADE

Year	Exports	Imports	Net Exports of Cotton
	($ 1,000)		
1963	576,649	24,009	552,640
1964	681,734	21,484	660,250
1965	486,169	18,240	467,929
1966	432,181	18,400	413,781
1967	463,813	27,067	436,746
1968	459,361	12,067	447,294
1969	280,238	6,326	273,912
1970	372,147	6,278	365,869
1971	583,150	6,510	576,640
1972	503,322	12,085	491,237
1973	928,969	6,174	922,795

Source: United States Foreign Agricultural Trade Statistical Report, Calendar Year 1973.

APPENDIX B

Evaluation of the Pilot Boll Weevil Eradication Experiment

U. S. Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine Programs
Methods Development Laboratories

ADMINISTRATIVELY CONFIDENTIAL
Not for Publication

Introduction

The Pilot Boll Weevil Eradication Experiment was initiated in July, 1971 and ran concurrently through August 10, 1973. The purpose of this experiment was to determine if it was technically and operationally feasible to eliminate the boll weevil, *Anthononus grandis*, from a specified area by integration of all available suppression techniques into an operational system.

This experiment was a cooperative effort involving 16 Federal, State, and industry agencies or groups (addendum 1). Responsibility for the implementation of the experiment was as follows:

1) Execution of the experiment: A special team of entomologists and inspectors in the Methods Development Branch of PP&Q, APHIS was assigned the responsibility of executing the field operations of the experiment. This team was made up of 23 professional personnel. Local people were employed on a temporary basis during peak operational periods.

2) Research: Research backup was provided by State and ARS scientists.

3) Extension: Information and education activities were provided by State and Federal Extension Services.

4) Regulatory: Quarantine and other regulatory requirements were provided by State Departments of Agriculture and APHIS.

Test Area

The area included in the eradication experiment covered all or parts of 30 counties in South Mississippi, 5 parishes in Louisiana, and 2 counties in

Alabama (Figure 1). It was necessary that the experiment be conducted in an area where the boll weevil was well established, populations consistently high and execution of control measures was difficult. Most fields were small, surrounded by high trees, and difficult to treat by aircraft. During the course of the experiment the average field size ranged from approximately 8 to 12 acres. This area was selected as being representative of the worst boll weevil conditions likely to be encountered in the boll weevil belt. It was felt by all concerned that if we could eliminate the boll weevil from this area, we could successfully execute this program in any part of the boll weevil infested area of the U. S.

The experiment was organized geographically with an eradication zone located in the center of a series of suppression areas (Figure 1). The eradication zone consisted of an area within a 25 mile radius of Columbia, Miss. Concentric buffer zones of approximately 50 miles in depth were established around the eradication zone. Table 1 gives the number of cotton acres planted in the different zones in 1971, 1972, and 1973. The actual evaluation of the test was done in the eradication zone. The buffer zones were designed to prevent or reduce the hazard of migration of boll weevils into the eradication zone. A test area of this size was necessary since it had been reported that the boll weevil could migrate up to 45 miles (Davich et al. 1970).

For coordination and operational purposes the area was divided into work units (Figure 2). One professional employee (unit supervisor) was in charge of and responsible for all operational activities conducted in his unit. A zone supervisor coordinated the activities carried out in each zone which

consisted of several work units. Overall coordination and supervision of the experiment was carried out by a supervisory entomologist who followed general procedures and guidelines set up by the Technical Guidance Committee for the Pilot Experiment.

Techniques and Methods Employed

The eradication scheme developed for use in the pilot eradication experiment involved the integrated use of several suppression techniques which included the use of chemical, biological, and cultural control methods. The suppression techniques were executed intensively in the eradication and first buffer zones. In the second and third buffer zones they were executed less intensively since these areas were designed to lessen the likelihood of boll weevil migration into the eradication zone.

The eradication scheme utilized eight techniques which were designed to progressively reduce the boll weevil population to achieve eradication. These techniques were as follows:

1) In-season control

The growers were urged to execute an effective in-season boll weevil control program throughout the test area. Experience had shown that diapause control is much more efficient when boll weevil populations are held below the economically damaging level during the growing season.

1971- In 1971 this phase was implemented primarily by the Cooperative Extension Services of the states involved. Producer meetings, newsletters, and radio programs promoted the need for good in-season insect control, kept producers informed on the boll weevil population levels in each individual field and made recommendations on insecticides and methods of applications, etc. Also, the boll weevil eradication experiment field personnel, through

individual contact, encouraged producers to carry out a good in-season control program using the Cooperative Extension Service recommendations. Although much effort was put forth to get producers to carry out on an adequate in-season control program the results were not very successful. It was estimated by the Cooperative Extension Service that only 25 percent of the acreage received a good in-season control program, 25 percent received a fair program, while 50 percent of the acreage received no in-season insecticide treatments.

1972- In view of the poor in-season control in 1971 the in-season control phase of the experiment in 1972 was carried out by the eradication experiment personnel of APHIS. All fields in the eradication and first buffer zones received five applications of azinphosmethyl at the rate of 0.25 lb. per acre or toxaphene + DDT + methyl parathion at the rate of 2 lb. + 1 lb. + 0.5 lb. per acre or DDT + azinphosmethyl at the rate of 1 lb. + 0.25 lb. per acre. Both fixed-wing aircraft and ground equipment were used to apply the treatments. Table 2 gives the application dates and the insecticide used on each application.

Due to field size, topography, or obstructions in the fields there were 110 acres that was impossible to treat with aircraft or ground equipment in 1972. Through the cooperation of the Agricultural Stabilization and Conservation Service we were allowed to purchase and destroy the cotton in these fields. Payment was based on the ASCS projected yield records and current cotton prices.

1973- Initial criteria for in-season control treatments in the eradication zone in 1973 required treatment if; (a) a total of at least 2 boll weevils per acre were captured in traps from beginning of trapping to finding 2

widely separated oviposition damaged squares or, (b) if 3 or more oviposition damaged squares were found (regardless of trap data). It was soon determined that some squares appearing to have oviposition damage did not and that sterile eggs were being deposited by native females as well as by the few sterile females (1-2 percent) that were being released with the sterile males. In view of this treatments were applied only in fields where, through the use of field survey, square dissection and egg hatch data, it was determined that a native boll weevil infestation existed. Where the infestation could be delimited to a small, localized spot in the field, only spot treatment was made. In the first buffer zone treatment was made to fields where an infestation was found and appeared to have the potential for rapid buildup. In the eradication zone pesticides were applied with ground equipment except when the fields were too wet. In this event aircraft was used. Depending on the type of field, obstructions, etc., both ground equipment and aircraft were used in the first buffer zone. Azinphosmethyl at 0.25 lb. per acre was applied on a 3 day interval. Table 3 gives the number of fields, acres, and treatment dates. Also 740 acres in the northern portion of the second buffer received 2 aerial treatments of azinphosmethyl from July 16-24, 1973 to prevent population buildup which would threaten the test area with migrating boll weevils.

2) Reproduction - diapause control

Fall insecticide treatments were applied at 5 to 12 day intervals beginning in August and continuing until frost to suppress late season boll weevil reproduction and prevent weevils from attaining diapause. Helicopters were used to apply the treatments in the eradication and first buffer zones and fixed-wing aircraft were used in the outer buffer zones. These treatments

were initiated the second week in August in the eradication and first buffer zones and on approximately September 1 in the outer buffer zones. The treatments were applied on a 5-day interval in August, a 5- to 7-day interval from September 1-15, a 7- to 10-day interval from September 15-30, and a 10- to 12-day interval after October 1. Tables 4 and 5 give the treatment dates for 1971 and 1972, respectively. In 1971 malathion was applied at the rate of 1.2 lbs. per acre and in 1972 azinphosmethyl was applied at the rate of 0.25 lb. per acre. All aerial treatments were applied as ultra-low-volume sprays. Also, in 1972, in addition to the aerial treatments high clearance spray machines and jeep-mounted mist blowers were used for supplemental treating in fields in the eradication and first buffer zones where adequate coverage could not be obtained with helicopters.

3) Cultural control - defoliation

All cotton in the eradication and first buffer zones was defoliated when it reached the recommended rate of maturity (60 percent open bolls and other bolls at least 25 days old). The defoliant DEF® or Folex® was applied at 1.5 pints per acre with water in a total mix of 5 gallons per acre. In 1971 83 percent of the acreage was defoliated from October 1-15 and the remaining acreage was done from October 20-27. In 1972 the crop matured earlier and defoliation was accomplished from September 1-29 as cotton in the various areas reached the proper stage. The purpose of the defoliation was to reduce the weevil's food sources and speed up harvest operations. Also the removal of the foliage made any weevils remaining on the cotton more vulnerable to contact with the insecticide applied for diapause control.

4) <u>Cultural control - stalk destruction</u>

Cotton stalks were destroyed mechanically in all fields harvested prior to the first killing frost, thus completely eliminating all boll weevil food and breeding sites in these fields. In 1971, only 2,724 of a potential 7,051 acres were destroyed prior to frost, whereas in 1972 harvest was completed earlier and 6,300 of a potential 6,811 acres were destroyed before frost.

5) <u>Pheromone traps</u>

Boll weevil pheromone traps were used around eradication and first buffer zone fields in the spring and summer to suppress the overwintered boll weevil population as emergence from hibernation quarters occured and to identify high boll weevil concentrations. The traps were located around the fields with particular attention to potential boll weevil hibernation sites. Fields that were planted to cotton the current year and unplanted fields that had been planted the previous year were trapped at an approximate rate of two traps per acre in 1972, and one trap per acre in 1973. At first the traps were baited twice per week with the synthetic pheromone, grandlure. As the formulation of grandlure was improved, traps were baited once per week. Two traps per field remained in service throughout the fall and winter to monitor boll weevil movement and population levels.

6) <u>Trap crops</u>

In 1972 and 1973 a four-row strip of trap crop cotton was planted in every cotton field in the eradication and first buffer zones. The trap crops were planted 2 to 3 weeks ahead of the producer's cotton in order for the trap crop cotton to be larger, fruit earlier, and be generally more attractive to boll weevils. This early planting was accomplished with the help

of a quarantine put forth by the State Regulatory Agencies which established that no producer cotton could be planted in the eradication and first buffer zones prior to April 15. This date was determined as the beginning of the optimum planting period for this area by the Cooperative Extension Service. The trap crops were baited with the synthetic boll weevil pheromone, grandlure, to enhance the attractiveness of the trap crop to boll weevils that entered the field. In order to kill the weevils that aggregated therein, the trap crop cotton received a 1 lb. AI per acre infurrow treatment of the systemic insecticide aldicarb at planting and a 2 lb. AI per acre sidedress treatment when the cotton reached the pinhead square stage approximately 6 to 7 weeks after planting. Also, foliar insecticide treatments of malathion or azinphosmethyl were applied to some trap crops that were still attractive to weevils after the aldicarb had lost its effectiveness.

7) Pinhead square treatment

A single insecticide treatment of azinphosmethyl of 0.25 lb. per acre was applied in 1972 to all cotton in the eradication and first buffer zones when the cotton reached the pinhead stage. This treatment was designed to kill any weevils that were not captured in traps or had not been killed in the trap crop prior to the fruiting stage of cotton which would allow weevil reproduction. In 1973 the pinhead square treatment was made only to those fields in which two or more adult boll weevils per acre were captured in traps prior to the development of the farmer cotton to this stage.

8) Sterile male releases

Laboratory-reared male boll weevils, sterilized with the chemosterilant busulfon, were aerially released on fields in the eradication and first buffer zones to eliminate reproduction by any individuals that may have survived the preceeding treatments. A genetic strain of the boll weevil characterized by ebony body color were used which permitted identification of the released weevils. Releases at weekly intervals started in early June and continued until mid-August. Free aerial releases were made from fixed-wing aircraft with a modified version of the release machine developed to drop sterile pink bollworm moths (Higgins 1970). Mechanical problems in the new Gast Boll Weevil Rearing Laboratory at Mississippi State University caused a shortage of sterile males for release in 1972. Most of these problems were solved and an adequate number of sterile male weevils were available for release in the eradication zone in 1973. Table 6 shows the number of acres on which sterile releases were made and the average number of sterile males released per acre in 1972 and 1973.

Evaluation

The eradication experiment was evaluated by: (1) making an intensive visual insect survey during each week of the cotton growing season. In the eradication and first buffer zones an infestation survey was made in each field each week unless prevented by rain or insecticide applications. In the eradication and first buffer zones, an infestation survey was made in each field of 10 acres or less and in each 10-acre increment in fields larger than 10 acres. In the second and third buffer zones infestation surveys were made on a per field basis in representative fields each week. Prior to squaring of the cotton, row counts for live adult boll weevils were made by examining both trap crop and farmer cotton. In 1972, five

spots of 50 feet each were checked in the trap crop. In 1973, at least five 50-foot checks were made in the trap crop and one 50-foot check in the farmer cotton. During the squaring period surveys were made by examining cotton squares in a diagonal route across the field and the level of infestation was determined as percent damaged squares. In 1971 and up to the week of June 19, 1972, 100 squares were examined per field. Starting the week of June 19, 200 squares were examined per field and in 1973 at least 300 squares were examined per field. In 1973, if a square was found that contained a viable egg or an immature boll weevil form, surveys were immediately intensified in that particular field to determine the size of the infestation and whether it was localized or general. As squaring began to terminate, surveys were made by "shagging" the adult weevils from 25 row feet of cotton at each of four spots to determine the estimated number of adults per acre. All surveys were oriented to the largest, greenest cotton in the field which was more attractive to boll weevils. This caused the population estimates to be biased in favor of detecting an infestation. It also caused population estimates to be larger than would be shown by random sampling.

(2) Ground trash from potential hibernation sites around the fields was collected and examined in the fall and spring of each year to determine the approximate number of boll weevils per acre that had survived the winter.

(3) Grandlure-baited pheromone traps were used to detect possible low level boll weevil infestations and "hot spots" in addition to their use for population suppression.

(4) In addition to visual surveys, tractor-mounted insect collecting machines were used to make intensive boll weevil surveys in 25 fields in

the eradication and first buffer zones in 1973 (E. P. Lloyd, 1973, Special Report attached).

(5) In 1973 all cotton squares showing possible boll weevil oviposition damage were collected from the field and brought into the laboratory where the squares were dissected and examined for the presence of boll weevil eggs or immature forms. All eggs were held for 5 days to determine hatch and immature forms were held for adult development. The results obtained enabled the identification of native boll weevil infestations and an evaluation of the effectiveness of the sterile male releases.

(6) In-field traps were placed in four fields in the eradication and first buffer zones as an additional method of evaluating the effectiveness of insecticide and sterile males in eliminating incipient boll weevil infestations (D. D. Hardee, 1973, Special Report attached).

Results

1971--In-season control in 1971, as estimated by the Cooperative Extension Service, was good on 25 percent of the acreage, 25 percent received a fair program, and 50 percent of the acreage received no in-season insecticide treatment. Fair or no boll weevil control on this much of the acreage allowed a high boll weevil infestation to develop throughout the area in July. During early July the percentage of oviposition damaged squares ranged from 22.8 to 56.7 in the various zones of the experimental area (Table 7). Reduction in the square infestation due to the diapause treatments initiated August 10 was gradual since continuous adult emergence occurred from the large number of eggs deposited in squares and bolls during July.

As squaring of the cotton began to terminate, live adult weevil surveys were made starting the week of September 1 in the eradication and first buffer zones and September 27 in the second and third buffer zones. At these times the average number of adults per acre was 1,700 in the eradication zone, 1,540 in the first buffer zone, 587 in the second buffer zone, and 2,720 in the third buffer zone (Table 7). The last adult population survey of the season, made the week of November 11 just prior to the first frost, showed that the malathion treatments, defoliation and stalk destruction had reduced the average number of adults per acre to 142 in the eradication zone, 108 in the first buffer zone, 16 in the second buffer, and 325 in the third buffer.

Following the first frost ground trash samples were collected from November 15-30. The number of diapausing boll weevils in ground trash ranged from a low of 130 per acre in the eradication zone to a high of 1,492 per acre in the adjoining untreated area outside the experimental area (Table 8). The spring ground trash samples for overwintered boll weevils were collected March 1-15. The overwintered population ranged from a low of 215 per acre in the first buffer zone to a high of 778 per acre in the adjoining untreated area. These data indicated high winter survival by the overwintering population.

Pheromone traps in service for survey purposes from the week of August 4, 1971, through the week of March 15, 1972, captured a total of 25,975 weevils in the eradication zone and 38,417 in the first buffer zone (Table 9). This amounted to an average of 2.1 and 2.8 weevils captured per trap week in the eradication and first buffer zones, respectively. In both zones weevils were captured during each week of the trapping period with the lowest number

captured during the month of February.

The importance of stalk destruction was emphasized when boll weevils were discovered overwintering in dried bolls which remained on undestroyed cotton stalks during the winter of 1971-72. Dried boll dissections on three different dates showed 27, 44, and 33 adults per acre overwintering in dried bolls in the eradication zone and 44, 22, and 9 adults per acre overwintering in the first buffer zone (Table 10).

1972--Pheromone traps were in service from mid-April to mid-July in 1972 to suppress the emerging overwintered boll weevil population. Overwintered boll weevil emergence from hibernation sites peaked over the period May 20 to June 20 (Table 11). In the eradication zone, a total of 156,580 boll weevils were captured in traps (average of 2.4 per trap week). This amounted to an average of 54 weevils trapped per acre of planted cotton. A total of 132,350 weevils or an average of 1.7 per trap week were captured in the first buffer zone, an average of 34 weevils trapped per acre of planted cotton.

The grandlure-baited, aldicarb-treated trap crop plantings of cotton proved to be a highly effective suppression measure against the overwintered boll weevils that entered the trap crop while the aldicarb was still effective. Field observations and a field experiment conducted to assess the value of trap crops as used in the pilot experiment (Scott et al. 1973) showed that in 1972 practically all of the weevils that entered the field prior to squaring of the farmer cotton moved into the trap crop and were killed after feeding on the aldicarb-treated plants.

Boll weevil field infestation surveys indicated that the release of sterile male boll weevils caused no measurable reduction in the native population in 1972. This is attributed to two things. (1) The native field population was too high to achieve an effective overflooding ratio of sterile males. (2) Quality control data showed that fertility of released males ranged from 10 to 40 percent while mortality ranged from 45 to 75 percent during the release period (Haynes et al. 1972).

During late May and early June of 1972 the adult boll weevil population found in trap crops ranged from 25 to 40 per acre in the eradication zone (Table 12). It should be noted that these populations were not representative of the total acreage of cotton since the trap crops are designed to aggregate boll weevils into a localized area which amounted to 3-5 percent of the field. By the last week in June, 74 percent of the farmer cotton fields in the eradication zone were infested with an average of 8 percent oviposition damage. This low-level, but general infestation, confirmed our fears that populations of boll weevils of possibly 10-50 per acre had survived all suppression measures of the preceeding fall and spring to attack the fruiting cotton.

It was felt that this was caused by several factors which included: (1) An inadequate in-season control program during the growing season in 1971. This resulted in extremely high populations of boll weevils in the fields when the scheduled reproduction-diapause treatments started. These populations were so high that even control at 95 percent plus still allowed many weevils to attain diapause during the treatment period. It is also possible that considerable numbers entered diapause in late summer prior to initiation of diapause treatments. (2) Also, it was evident that we had

to improve upon the efficiency of application of pesticides in the diapause treatment. This was necessary because of the many fields which were difficult to treat by aircraft.

To correct these problems the following actions were taken: (1) APHIS (USDA) personnel applied the necessary in-season control treatments as recommended by the Extension Service. (2) Supplemental ground insecticide treatments were made with high clearance spray machines and jeep-mounted mist blowers in those fields which were difficult to treat by aircraft. These treatments were initiated the week of July 12 and continued until the scheduled diapause treatments started on August 7. Supplemental treatments were made on the same schedule as aerial applications.

As the cotton reached maturity in early September, live adult weevil surveys were again used to measure the size of the population. From early September to mid-October the population in the eradication zone fluctuated from one to 13 adults per acre (Table 12). The week of October 18, no adults were detected in field surveys and the population remained at zero or a nondetectable level throughout the remainder of the season.

The boll weevil infestations were held at low levels throughout the period of maximum diapause development, from mid-July until frost killed the cotton. During this period square infestations never exceeded 5 percent and adults per acre ranged from 0-13. These results led us to expect that overwintering weevils were much lower in 1972 than in 1971, possibly by a factor of 100 fold.

The infestation levels in the first buffer zone generally followed the same trend as in the eradication zone, except that the infestation was slightly lower in the early part of the season and slightly higher in the latter part. By early November the population had reached a non-detectable level.

Infestation levels in the second and third buffer zones in 1972 are shown in Table 12. The average percentage of oviposition damaged squares in the second buffer was slightly higher than in the third buffer zone, but the adult population was generally lower. The final population count in 1972 showed a population of 43 adults per acre in the second buffer zone and 213 per acre in the third buffer.

Pheromone traps in operation for survey captured 2,999 boll weevils (average of 0.09 per trap week) in the eradication zone and 4,480 boll weevils (average of 0.1 per trap week) in the first buffer zone from July 19, 1972, through April 11, 1973, (Table 13). The capture of weevils in traps during the latter part of the season when adults could not be detected in field surveys indicated two possibilities: (1) migration of weevils into the eradication and first buffer zones and/or, (2) very low populations that were not detected by field surveys. However, 94 percent fewer weevils were captured from August through November, 1972, than during the same period in 1971.

Ground trash samples collected in the fall of 1972 revealed no boll weevils in trash in the eradication or first buffer zones compared with 130 per acre and 235 per acre, respectively in 1971. An average of 380 per acre were found in the second buffer, 143 per acre in the third buffer and 645 per acre in the untreated area outside the experimental area (Table 7).

No weevils were detected in spring ground trash examinations in 1973 in the eradication and first buffer zones as compared to an average of 440 per acre in the outside untreated area. Wood's trash samples were not collected in the second or third buffer zones in the spring of 1973. Fall field surveys, trap collections, and fall and spring wood's trash examinations in the eradication and first buffer zones showed that the boll weevil population had been reduced to an extremely low level.

1973--Pheromone traps in operation to suppress the overwintered boll weevil population in 1973 captured 1,436 boll weevils, an average of 0.03 per trap week in the eradication zone from April 18 to August 1. In the first buffer zone 3,940 boll weevils, an average of 0.06 per trap week, were captured during the same period (Table 14). An average of 0.8 weevils per acre was captured per acre of planted cotton in both the eradication and first buffer zones. Ninety-nine and 97 percent fewer weevils were captured in the eradication and first buffer zones, respectively in 1973 compared to 1972.

Figure 3 shows that 36.8 percent of the weevils collected in the eradication zone were captured in the northern most unit (Unit 4). Eighteen percent of these were captured at the location of a 2-acre field not found until September 21, 1972. Apparently many weevils attained firm diapause and entered hibernation from this field before it was found and treated. The percentage of weevils trapped in other units of the eradication zone ranged from 14.6 to 0.3 percent. Considerably fewer weevils were captured in the southern portion of the eradication zone. In the first buffer zone

45.5 percent and 36.9 percent of the total weevils were captured in unit 2 and unit 3, respectively. These two units were directly north of the eradication zone and adjacent to heavily infested cotton acreage in the second buffer zone. Each of the other units yielded from 6.6 to 1.7 percent of the total weevils.

Table 15 gives the results of pheromone traps operated in selected fields in the northern and eastern portion of the second buffer. From April 25 through August 8, a total of 40,172 boll weevils (average 5.8 per trap week) were captured. The majority of these were captured in the area immediately north of unit 2 and 3 in the first buffer zone. In comparison only 0.03 and 0.06 weevils per trap week were captured in the eradication and first buffer zones, respectively, while approximately 18 weevils per trap week were captured around fields outside of the treated area (D. D. Hardee, BWRL, unpublished data). These differences indicate the relative effectiveness of the suppression measures applied in each of the zones of the experimental area. Weevil collections in traps show the peak emergence period in the second buffer zone occurred from May 30 through June 13, at least 1 week earlier than in the eradication or first buffer zone. These populations in the second buffer zone were the major source of migrants into the eradication zone during the evaluation period in July and August.

The collection of native and sterile boll weevils in field surveys in the eradication zone in 1973 is shown in Table 16. From the week of May 9 through August 8, nine native adults were found in nine different trap crops with seven of these found in June. In farmer cotton 19 native adults

were found in 15 fields. The total weevils found in trap crops and farmer cotton averaged 0.015 native adult boll weevils per acre found in the eradication zone. Based on visual surveys the overflooding ratio of steriles to natives for the season averaged 56.4 to 1 in trap crops and 11.6 to 1 in farmer cotton.

Intensive sampling with insect collecting machines was carried out in 18 representative fields in the eradication zone from June to August 3, to compare the relative efficiency of machine sampling and visual sampling for detecting low level boll weevil infestations (E. P. Lloyd, 1973, Special Report attached). The study was also done to determine the relative abundance of boll weevils in the trap crops and normal plantings. From June 4 through August 3, 10 native boll weevils were detected in six trap crops and one native adult was detected in one field of farmer cotton. This field of farmer cotton (Field 61, Unit 6) was the earliest planted field in the area thus being almost as attractive to weevils as the trap crop. These collections showed a 98.5 to 1 average overflooding ratio of steriles to natives in trap crops and a 149 to 1 ratio in farmer cotton.

In visual surveys for oviposition damaged squares in the eradication zone, 2,279 suspect squares were detected in fields 183 collections (Table 17). Correcting repeat collections during the same weeks or successive weeks this amounted to 77 individual fields with the majority of these being in the northernmost unit (Unit 4). The weeks of July 11, 18, and 25, were the most critical. During this period 68 percent of the suspect squares were detected.

The intensive machine sampling detected two squares containing larvae in two trap crops and none in farmer cotton (E. P. Lloyd, 1973, Special Report attached). In one of these fields (Field 61, Unit 6) the trap crop was treated with insecticide and no other infested squares were found in the intensive sampling or the visual sampling during the rest of the season. In the other field (Field 110, Unit 4) boll weevil infested squares were also detected in the visual survey. This field in unit 4 was the northernmost field being sampled in the intensive machine sampling.

Table 18 gives the results of square dissections and the percent field sterility obtained from sterile males released in the eradication zone based on the number of immatures found and the number of eggs which hatched. From July 9-27 224 immatures and 682 eggs of which 24 hatched were found in 52 fields. All immatures and fertile eggs were found in the northern 1/3 of the zone (Units 3, 4, and 5). During this period percent sterility in individual fields in all units ranged from 50 to 100 percent and averaged 72 percent. During the last 2 weeks of the experiment, July 30-August 10, 53 immatures and 68 eggs, of which 22 hatched, were found in 13 fields. Again all of these came from Units 3, 4, and 5. The last week of the experiment, eggs of which none hatched, were detected in four fields and immatures were found in two fields, both in Unit 5. Eleven larvae were found in one of these fields which was the first detection, while one pupa was found in the other field in which an immature had been detected the previous week. From July 30-August 10 the percent sterility in the field ranged from 0 to 100 percent and averaged 38 percent. The low sterility observed in the field during this period can in part be accounted for by the

fact that fallen squares containing late instar larva or pupa were collected from fields known to have been infested previously.

Laboratory quality control data on sterile males released through July 31 showed that a satisfactory level of sterility (95.9 to 99.7 percent) was maintained for at least 3 weeks after each sterilization period (N. W. Earle and E. Villavasco, unpublished data). This data plus the fact that adults reared from the immature collections were natives with one exception (two bronze (native x ebony) weevils were reared from larvae collected in field 35, Unit 4), indicated that the majority of the larvae and fertile eggs found came from previously mated females which had migrated into the northern portion of the eradication zone.

Table 19 shows the number of fields and acres in which incipient infestations of boll weevils were detected in the units of the eradication zone in 1973. Out of a total of 1,817 acres in 236 fields, boll weevil infestations were detected in 34 fields (14.4 percent) amounting to 167 acres (9.2 percent). Sixty-one and eight-tenths percent of the infested fields and 68.2 percent of the infested acreage was located in Unit 4 which was adjacent to considerable boll weevil infested cotton acreage outside the eradication zone. Twenty-three and five-tenths percent of the infested fields was in Unit 5 and 14.7 percent was in Unit 3. No infestations were detected in Units 1, 2, and 6. Figure 4 shows the location of the infested fields in the eradication zone. All infested fields were located in the upper one-third of the zone.

Extensive infestation surveys showed that the azinphosmethyl treatments applied to all infested fields on a 3-day interval stopped boll weevil

reproduction in all fields with one exception. This field in Unit 5 was first detected the week of August 8, so near the termination of the experiment that it was not possible to execute the suppression measures for elimination before the experiment was terminated. In-field traps captured adult boll weevils in three of four fields in Unit 4 during the weeks of July 30 and/or August 6 (D. D. Hardee, 1973, Special Report, attached). Since many of these were obviously newly emerged adults and in each case could be correlated to the last detection of an egg or an immature form, these adults in all probability developed from eggs oviposited prior to the termination of reproduction with the insecticide treatments.

Field surveys were conducted in a biased fashion in order to be able to detect an incipient infestation and apply control measures before any sizeable population increase occurred. This was considered as the final and most important factor in conducting a successful program, since we expected that late emerging overwintered weevils and possibly migrant weevils would start incipient infestations. Based on trap collections and field observations, infestations began at random points in fields rather than near overwintering sites. This indicated infestations which developed in July were caused by migrating previously mated females. Insecticide treatments were applied to eliminate these incipient infestations. In the southern two-thirds of the eradication zone, insecticide treatments were not required to achieve elimination. Results of the intensive sampling study showed that this procedure was effective in all intensively sampled fields where an infestation occurred (E. P. Lloyd, 1973, Special Report attached).

From the week of May 9 through August 8 in the first buffer zone 49 native adults were found in 29 trap crops and 39 native adults were found in 29 fields of farmer cotton (Table 20). During this period the ratio of sterile to native adults averaged one to one in trap crops and 0.8 to 1 in farmer cotton. This is a much lower ratio than in the eradication zone, but considerably fewer weevils were released in the first buffer zone.

Square surveys in the first buffer zone detected 2,072 suspect oviposition damaged squares in fields on 230 occassions which amounted to 136 individual fields (Table 21). These squares contained 493 immatures and 333 eggs of which the majority came from Units 2 and 3. These units were directly north of the eradication zone and adjacent to the largest amount of boll weevil infested cotton acreage in the second buffer zone.

Intensive machine sampling in seven fields in the first buffer zone from June 4 through August 3 found 23 native adults in trap crops and seven native adults in farmer cotton (E. P. Lloyd, 1973, Special Report attached). Native weevils were captured in six of the seven fields by intensive sampling in this zone. The only field where native weevils were not detected by intensive sampling was in Unit 1 which was not subjected to heavy migration pressure as were the other fields. The ratio of sterile to native adults averaged 2.6 to 1 in trap crops and 2 to 1 in farmer cotton in Zone 2.

In the second buffer zone from mid to late June the adult population ranged from an average of 40 to 87 per acre (Table 22). The percentage of fields

where adults were found increased from 14 percent in Mid-June to 64 percent by late June. When field surveys were begun in early July, oviposition damaged squares were averaging 4.0 percent and 95 percent of the fields were found to be infested. This increased to 6.0 percent in 94 percent of the fields by mid-July at which time insecticide treatments were applied to prevent population buildup. During the remainder of the season the oviposition damaged squares ranged from 0.1 to 2.0 percent and were found in 18 to 55 percent of the fields.

Discussion

The area in which the pilot eradication experiment was conducted was selected as being representative of the most difficult area and situation from which to eradicate this pest. With many small, hard to treat fields surrounded by numerous hibernation sites, in a climate condusive to optimum boll weevil development, it was evident that the criteria for site selection were fully met.

The major problem encountered in 1971 was failure of cotton producers to implement an effective in-season control program. In comparing the data collected in 1971 and 1972, it is apparent that the reproduction-diapause treatments must be preceeded by a good in-season boll weevil control program if the boll weevil population is to be low enough to achieve elimination. This is shown by the fact that in 1972 the percentage of boll weevil oviposition damaged squares in the eradication zone was 90 percent less than in 1971 and the average number of adults per acre was 99.6 percent less. It should be noted, however, that fall insecticide treatments alone did considerably reduce the population. In the second

buffer zone, which received seven insecticide treatments in the fall, the adult population was an average of 75 percent less than in 1971. In the third buffer zone, which received only four insecticide treatments in the fall, the adult population was an average of 55 percent less in 1972 than in 1971. These data appear to be an accurate measure of the three different diapause treatment schedules. However, a diapause control program without effective in-season control permits a sizeable weevil population to attain diapause and overwinter.

It may seem that large amounts of insecticide had to be applied to this area in preparation for the final steps toward boll weevil elimination. However, in a normal cotton growing area where good insect control practices are followed, this much insecticide and more may be applied year after year in an attempt to obtain maximum production. Elimination of the boll weevil would cause a drastic reduction in the amount of insecticide required each year. Treatments would be necessary only to control sporadic outbreaks of other insects under circumstances condusive to population buildup. With less pesticide being used, more dependability could be placed upon control of other pests by indigenous predators and parasites and other pest management practices.

Since boll weevils must feed on cotton fruit to build up fat reserves and attain diapause, it is felt that cotton plant defoliation and stalk destruction played an important role in reducing the number of diapausing boll weevils in the fall of the year. If done prior to frost, stalk destruction will reduce the number of insecticide treatments that have to be applied and also eliminate the possibility of weevils overwintering in dried bolls left on standing stalks as was found in the winter of 1971-72.

Grandlure-baited traps provided an excellent tool for surveying low weevil populations, suppressing overwintered weevil populations, and measuring migration. The traps were effective in capturing low numbers of weevils around fields where adult surveys could not detect any weevils in the fall of 1972. They were also effective in capturing large numbers of overwintered weevils in 1972 and were felt to be more effective in 1973 since an improved formulation of grandlure was used as well as the fact that the trap is more efficient on low level populations (Hardee et al. 1970) such as existed in the spring of 1973.

An examination of figures 3 and 4 shows that in 1973 there was an increase in native weevils captured and infested fields as you move from south to north in the test area. This increasing incidence of captured weevils and infestations was directly related to the distance from considerable cotton acreage outside the eradication experiment area (Figure 5). The apparent relationship between these factors indicated that boll weevil migration into the eradication zone did occur. A migration study for the purpose of determining if weevil migration into the eradication zone did occur confirmed this (W. H. Cross 1973, Special Report attached). Results of this test showed a definite gradiant of weevils captured at noncotton field locations from the second buffer zone into the first buffer and eradication zones. In a release and recapture study, weevils were captured up to 33 miles from the point of release.

While trap crops in various forms has been recommended since 1901 (Malley 1901), this is the first organized, area-wide use of this technique over a large area. The data in this report as well as data collected by others

(Scott et al. 1973, Gilliland et al. 1973, D. R. Rummel, unpublished data) indicates that trap crop techniques can be highly effective as a pest management and/or eradication tool for boll weevils. Trap crops may also have value for use in managing other insect pest populations such as Heliothis spp. (Gilliland et al. 1973). It is felt that with some slight modifications that the trap crop technique can be used on even a more practical basis over a large area. This can probably be achieved by baiting narrow strips of farmer cotton by aircraft with the optimum amount of the pheromone, grandlure, and applying foliar insecticides to kill the boll weevils that are attracted to it.

The detection and determination of a native boll weevil infestation in 1973 was difficult under the low level populations that existed. In the evaluation of this test it was known that (1) a few sterile females were released which were capable of depositing sterile eggs, and, (2) native females would deposit sterile eggs after mating with sterile males. Therefore, to identify an incipient native infestation, it was necessary to go beyond the mere detection of oviposition. The determination of egg hatch and larval development were extremely important in identifying a native infestation since the present sterility in the field in the units of the eradication zone ranged from 0 to 100 percent at various times during the season. This was apparently governed by the location and distance of each unit from boll weevil infested cotton outside of the eradication zone. Thus in order to determine if a field was actually infested by native boll weevils, experience gained during the course of the experiment showed that two things must exist: (1) proliferated squares

with normal eggs or larvae, (2) one or more flared squares on the plant or shed squares on the ground. This was also followed up by observation of eggs for development.

In all fields where suspect oviposition damaged squares were found the surveys were intensified and several different individuals checked these fields carefully several weeks in succession. With close consideration given to all possible factors only 14.4 percent of the fields comprising 9.2 percent of the acreage in the eradication zone was found infested in 1973. In view of the fact that all of the fields were located in the northern one-third of the zone where the majority of the weevils were captured in traps and that the field trap data and migration study data strongly indicated that migration into that area did occur, it surmised that the majority of the infestations found in 1973 were caused by migrant, gravid females.

Conclusion

Based on the results of the pilot eradication experiment and mindful that the experiment was conducted in an area representative of the most severe boll weevil conditions likely to be encountered in the boll weevil belt, it was concluded by the Pilot Boll Weevil Eradication Experiment Technical Guidance Committee that it is technically and operationally feasible to eliminate the boll weevil as an economic pest from the United States by the use of techniques that are ecologically acceptable.

REFERENCES CITED

Davich, T. B., D. D. Hardee, and M. J. Alcala. 1970. Long-range dispersal of boll weevils determined with wing traps baited with males. J. Econ. Entomol. 63:1706-8.

Gilliland, F. R., Jr., W. R. Lambert, J. R. Weeks, and R. L. Davis. 1973. A pest management system for cotton insect suppression. J. Econ. Entomol. In preparation.

Hardee, D. D., W. H. Cross, P. M. Huddleston, and T. B. Davich. 1970. Survey and control of the boll weevil in West Texas with traps baited with males. J. Econ. Entomol. 63(4):1041-8.

Haynes, Jack, J. Darvson, Essie Mattix, and Norman Mitlin. 1972. Quality control data for the Pilot Boll Weevil Eradication Experiment in south Mississippi. U.S. Dep. Agr., Agr. Res. Serv., Boll Weevil Res. Lab. Third Quarterly Rpt. p. 17-18.

Higgins, Albert H. 1970. A machine for free aerial release of sterile pink bollworm moths. U.S. Dep. Agr., Agr. Res. Serv. ARS 81-40. 10 pp.

Malley, F. W. 1901. The Mexican cotton-boll weevil. USDA Farmer's Bulletin 130. p. 11-12.

Scott, W. P., E. P. Lloyd, J. O. Byrson, and T. B. Davich. 1973. Trap crops for the suppression of low density overwintered boll weevil populations. J. Econ. Entomol. (In press).

Table 1. Cotton acreage in the different zones of the Pilot Boll Weevil Eradication Experiment during 1971, 1972, and 1973.

	No. of acres		
Zone	1971	1972	1973
Eradication	3,222	2,906	1,817
1st buffer	3,829	3,905	4,894
2nd buffer	4,774	3,041	2,226[a]
3rd buffer	11,912	9,449	9,967[a]
Total	23,737	19,301	18,904

[a] Approximate acreage as estimated by the Cooperative Extension Service, Mississippi State University.

Table 2. Insecticide used and inclusive application dates of in-season boll weevil control insecticide treatments in the eradication and first buffer zones in 1972.

	Eradication		1st buffer	
Application No.	Insecticide	Date	Insecticide	Date
1	Azinphosmethyl	7/10-12	Azinphosmethyl	7/13-17
2	"	7/16-19	"	7/19-22
3	"	7/22-24	Azinphosmethyl + Tox-DDT-MP	7/24-30
4	Tox-DDT-MP[a/]	7/29-30	Tox-DDT-MP + DDT + Azinphosmethyl	7/30-8/2
5	DDT + Azinphosmethyl[a/]	8/1-3	DDT + Azinphosmethyl + Azinphosmethyl	8/3-8

[a/] All Tox-DDT-MP and DDT applied for bollworm control.

Table 3. Number of fields and acres treated with insecticide during indicated weeks in the eradication and first buffer zones in 1973.

	Eradication zone		1st buffer zone	
	No. of		No. of	
Week of	Fields	Acres	Fields	Acres
June 6	0	0	1	6
13	0	0	1	5
20	10	74	8	50
27	16	80	31	245
July 4	2	10	5	23
11[a]	2	5	53	451
16	12	62	41	348
25	28	137	26	209
Aug. 1	31	158	39	291
8	18	90	-	-

[a] All treatments applied prior to the week of July 11 were based on trap catch or suspect oviposition damaged squares. After this data they were based on native boll weevil infestations.

Table 4. Inclusive application dates of reproduction - diapause boll weevil control treatments applied in the boll weevil eradication experiment area in 1971.

	Zone			
Application No.	Eradication	1st buffer	2nd buffer	3rd buffer
1	8/ 9-16	8/ 9-15	8/30-9/7	8/30-9/7
2	8/14-18	8/14-18	9/ 6- 9	9/13-21
3	8/19-25	8/19-25	9/13-15	9/27-30
4	8/24-28	8/24-28	9/20-22	10/12-14
5	8/30-9/5	8/30-9/4	9/28-30	
6	9/ 7- 9	9/ 6- 8	10/ 7- 8	
7	9/13-18	9/13-15	10/18-21	
8	9/21-22	9/21-24	10/29-30	
9	9/27-30	9/27-30		
10	10/ 7- 9	10/ 7- 9		
11	10/18-20	10/18-20		
12	10/28-29	10/28-29		
13	11/ 9-10	11/ 9-10		

Table 5. Inclusive application dates of reproduction - diapause boll weevil control treatments applied in the boll weevil eradication experiment area, 1972.

	Zone			
Application No.	Eradication	1st buffer	2nd buffer	3rd buffer
1	8/ 9-12	8/ 7-12	8/21-23	9/ 7-10
2	8/12-17	8/12-15	9/ 6- 7	9/19-21
3	8/18-19	8/17-19	9/12-14	10/ 2- 5
4	8/22-25	8/22-25	9/21	10/16-20
5	8/27-29	8/27-29	10/ 2- 3	
6	9/ 3- 4	9/ 3- 5	10/16-17	
7	9/11-14	9/11-13	10/30-11/1	
8	9/18-20	9/18-20		
9	9/26-28	9/26-28		
10	10/ 5- 8	10/ 5- 8		
11	10/16-17	10/16-17		
12	10/30-11/1	10/30-11/1		
13	11/9-11	11/9-11		

Table 6. Total number of acres in the eradication and first buffer zones receiving sterile male boll weevils in 1972 and 1973 and the average number of males released per acre.

	1972		1973	
Week of	No. Acres	Avg. no. of males released/acre	No. Acres	Avg. no. of males released/acre
June 6	2090	50	3323	76
13	2961	55	5516	70
20	3856	51	3038	68
27	3926	53	3294	50
July 4	1625	59	3786	74
11	1823	36	5305	63
16	1104	100	2777	52
25	675	104	5370	54
Aug. 1	896	124	5074	57
8	792	129	3545	70

Table 7. Boll weevil infestation levels in the different zones of the Pilot Boll Weevil Eradication Experiment in 1971.

Week of	Eradication	1st buffer	2nd buffer	3rd buffer
		Avg. % oviposition damaged squares		
July 5	43.2	22.8	-	-
12	46.1	26.9	40.6	56.7
19	36.9	17.4	25.9	44.9
26	37.4	16.9	34.5	31.5
Aug. 2	44.1	22.8	33.0	28.9
9	55.6	27.8	53.4	35.9
16	43.8	27.6	35.0	26.6
23	27.1	18.6	38.2	45.4
30	28.7	16.9	16.8	-
	Avg. no. of adults/acre			
Sept 6	1700	1540	33.4	41.6
13	1209	720	19.9	-
20	1446	1082	6.5	19.4
			Avg. no. of adults/acre	
27	1446	717	587	2720
Oct. 4	780	579	613	1392
11	344	203	350	1693
18	416	191	342	1051
25	350	295	774	907
Nov. 1	240	173	361	648
8	142	108	16	325

Table 8. Results of ground trash samples collected in the Pilot Boll Weevil Eradication Experiment Area in 1971, 1972, and 1973.

	No. of square yards of trash sampled				Avg. no. of diapausing boll weevils per acre			
	1971	1972		1973	1971	1972		1973
Zone	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Eradication	600	539	600	565	130	395	0	0
1st buffer	520	517	580	580	235	215	0	0
2nd buffer	275	310	140	0	629	484	380	--
3rd buffer	320	210	135	0	301	392	143	--
Untreated area	290	230	150	110	1492	778	645	440

Table 9. Results of boll weevil pheromone traps in service for survey purposes in the eradication and first buffer zones from the week of August 4, 1971 through the week of March 15, 1972.[a]

	Eradication zone		1st buffer zone	
Week of	No. of BW trapped	Avg. no. captured per trap week	No. of BW trapped	Avg. no. captured per trap week
Aug. 4	1,263	19.7	143	2.8
11	1,454	23.4	1,565	8.6
18	1,344	10.7	1,450	7.2
25	422	2.1	2,416	12.7
Sept. 1	809	3.8	1,793	5.8
8	2,078	17.3	2,031	6.2
15	3,067	8.0	1,973	5.6
22	1,617	3.4	4,266	8.4
28	2,028	4.0	2,697	4.5
Oct. 6	1,606	3.1	2,564	4.6
13	1,283	2.5	2,328	4.3
20	1,259	2.4	1,950	3.7
27	1,047	1.9	1,479	2.7
Nov. 4	1,052	1.9	1,141	2.1
11	595	1.1	556	1.1
18	986	2.5	2,418	5.3
25	491	1.3	1,839	4.8
Dec. 2	555	1.1	512	1.1
7	153	0.3	142	0.3
14	618	1.2	1,622	2.9

Table 9. Continued

Week of	Eradication zone: No. of BW trapped	Eradication zone: Avg. no. captured per trap week	1st buffer zone: No. of BW trapped	1st buffer zone: Avg. no. captured per trap week
Dec 23	289	0.6	1385	2.6
30	481	1.0	531	1.2
Jan. 3	170	0.4	426	0.8
12	80	0.2	123	0.2
19	396	0.8	172	0.3
26	157	0.3	71	0.1
Feb. 2	67	0.1	37	0.07
9	42	0.1	7	0.01
16	43	0.1	1	0.002
23	34	0.1	4	0.009
Mar. 1	156	1.7	163	1.3
8	63	0.8	183	1.4
15	270	2.7	429	3.2
Total or Avg.	25,975	2.1	38,417	2.8

[a] Traps were operated at the rate of two per field for a total of 12,367 trap weeks in the eradication zone and 13,889 trap weeks in the first buffer zone.

Table 10. Results of boll dissections to determine the number of boll weevils overwintering in dried cotton bolls remaining on undestroyed cotton stalks in 1971.[a]

Zone	Date	No. of bolls sampled	No. adults found		No. immatures[b]		Diapause status[c]			Avg. no. of adults/acre
			Live	Dead	Larvae	Pupae	N	I	D	
Eradication	Jan. 20	3,294	5	87	5	3	2	0	3	27
	Feb. 12	2,060	4	35	0	1	1	0	3	44
	Feb. 28	1,215	3	16	0	0	0	1	2	33
1st buffer	Jan. 20	2,839	8	44	2	4	0	2	6	44
	Feb. 12	1,300	2	29	0	0	1	0	1	22
	Feb. 28	1,215	0	13	1	0	-	-	-	0

a/ Sample size: January 20, 100 row ft. in each of 24 fields per zone; subsequent dates, 100 row ft. in each of 12 fields per zone.

b/ All immatures dead.

c/ Number of boll weevils in N=non-diapause, I = intermediate diapause, D = firm diapause.

Table 11. Results of pheromone traps in operation in the eradication and first buffer zones for suppression of the overwintered boll weevil population in 1972.[a/]

Week of	Eradication zone: No. of BW trapped	Eradication zone: Avg. no. captured per trap week	Eradication zone: Avg. no. trapped per acre	1st buffer zone: No. of BW trapped	1st buffer zone: Avg. no. captured per trap week	1st buffer zone: Avg. no. trapped per acre
April 18	-	-	-	3,471	0.7	0.9
25	7,847	1.3	2.7	2,925	0.4	0.8
May 2	3,391	0.5	1.2	1,481	0.3	0.4
9	3,472	0.5	1.2	1,442	0.2	0.4
16	4,738	0.8	1.6	1,273	0.2	0.3
23	18,586	2.9	6.4	18,103	2.6	4.6
30	27,361	4.6	9.4	23,133	3.4	5.9
June 6	20,931	3.3	7.2	20,496	3.0	5.2
13	27,177	4.6	9.4	26,070	3.8	6.8
20	22,886	4.1	7.9	19,510	2.9	5.0
27	10,058	2.2	3.5	8,781	1.6	2.2
July 4	3,281	1.5	1.1	3,335	1.5	0.9
11	6,852	2.7	2.4	2,330	0.7	0.6
Total or Avg.	156,580	2.4	54.0	132,350	1.7	34.0

a/ Traps were in service for a total of 65,022 trap weeks in the eradication zone and 77,739 trap weeks in the first buffer zone.

Table 12. Boll weevil infestation levels in the different zones of the Pilot Boll Weevil Eradication Experiment in 1972.

Week of	Eradication	1st buffer	2nd buffer	3rd buffer
		Avg. no. of adults/acre		
May 24	40	10	-	-
31	25	10	-	-
June 7	40	15	-	-
		Avg. % oviposition damaged squares		
14	2.0	2.7	-	-
21	5.4	1.3	-	-
28	7.8	2.3	-	-
July 5	5.6	4.3	-	-
12	8.6	4.7	20.3	17.1
19	5.6	8.1	24.0	15.1
26	3.9	4.9	22.0	22.0
Aug. 2	4.3	5.5	24.5	18.4
9	2.3	4.1	30.4	24.0
16	2.0	3.0	32.9	29.6
23	2.2	1.7	21.6	19.4
30	0.7	2.4	36.4	23.8
		Avg. no. of adults/acre		
Sept 6	4	26	-	950
13	6	14	311	955
20	2	3	-	646
27	13	9	523	915

Table 12. Continued.

Week of	Eradication	1st buffer	2nd buffer	3rd buffer
Oct. 4	6	11	195	474
11	1	9	286	348
18	0	3	44	-
25	0	0	193	108
Nov. 1	0	0.9	99	169
8	0	0	43	213
15	0	0	-	-
22	0	0	-	-

Table 13. Results of pheromone traps in service for survey purposes in the eradication and first buffer zones from the week of July 19, 1972 through the week of April 11, 1973.[a]

	Eradication zone		1st buffer zone	
Week of	No. of BW trapped	Avg. no. captured per trap week	No. of BW trapped	Avg. no. captured per trap week
July 19	942	0.8	395	0.4
26	542	0.5	276	0.2
Aug. 2	234	0.3	96	0.09
9	87	0.2	45	0.05
16	71	0.1	82	0.07
23	50	0.1	41	0.05
30	75	0.1	216	0.2
Sept. 6	56	0.06	198	0.2
13	87	0.09	87	0.08
20	26	0.03	156	0.1
27	79	0.08	218	0.2
Oct. 4	35	0.03	155	0.1
11	181	0.2	1,137	0.8
18	132	0.1	256	0.2
25	50	0.3	103	0.05
Nov. 1	94	0.06	119	0.05
8	71	0.05	401	0.2
15	72	0.05	253	0.1
22	4	0.003	38	0.03
29	1	0.002	5	0.005

Table 13. Continued.

	Eradication zone		1st buffer zone	
Week of	No. of BW trapped	Avg. no. captured per trap week	No. of BW trapped	Avg. no. captured per trap week
Dec. 6	58	0.07	64	0.06
13	30	0.05	67	0.1
20	6	0.008	42	0.05
27	5	0.02	5	0.005
Jan. 3	5	0.006	9	0.01
10	0	0	0	0
17	1	0.001	2	0.002
24	1	0.001	5	0.006
31	0	0	0	0
Feb. 7	1	0.004	0	0
14	0	0	1	0.001
21	0	0	0	0
28	0	0	0	0
March 7	0	0	0	0
14	1	0.001	0	0
21	0	0	0	0
28	0	0	0	0
April 4	0	0	2	0.003
11	2	0.004	6	0.007
Totals or Avg.	2,999	0.09	4,480	0.1

Table 14. Results of pheromone traps in operation in the eradication and first buffer zones for suppression of the overwintered boll weevil population in 1973.[a]

	Eradication zone			1st buffer zone		
Week of	No. of BW trapped	Avg. no. captured per trap week	Avg. no. trapped per acre	No. of BW trapped	Avg. no. captured per trap week	Avg. no. trapped per acre
April 18	12	0.004	0.007	33	0.007	0.007
25	21	0.008	0.01	16	0.004	0.003
May 2	28	0.01	0.02	70	0.02	0.01
9	57	0.02	0.03	187	0.04	0.04
16	53	0.02	0.03	230	0.05	0.05
23	61	0.02	0.03	106	0.02	0.02
30	85	0.03	0.05	189	0.04	0.04
June 6	158	0.06	0.03	510	0.11	0.10
13	295	0.10	0.16	1,036	0.22	0.22
20	177	0.06	0.10	526	0.11	0.11
27	221	0.07	0.12	476	0.10	0.10
July 4	158	0.05	0.09	229	0.04	0.05
11	51	0.02	0.03	158	0.03	0.03
18	135	0.01	0.02	119	0.02	0.02
25	15	0.005	0.008	45	0.01	0.009
Aug. 1	9	0.006	0.004	10	0.005	0.002
Total or Avg.	1,436	0.03	0.8	3,940	0.06	0.6

[a] Traps were in service for a total of 42,605 trap weeks in the eradication zone and 70,400 trap weeks in

Table 15. Results of pheromone traps in operation in the inner half of the northern and eastern portion of the second buffer zone in 1973.[a]

Week of	No. of BW trapped	Avg. no. captured per trap week
April 25	209	1.6
May 2	169	1.3
9	2,909	6.5
16	3,052	5.1
23	3,717	6.2
30	7,576	12.7
June 6	6,676	12.3
13	7,865	14.5
20	4,157	6.7
27	1,736	3.1
July 4	795	1.5
11	893	1.5
18	262	0.6
25	91	0.4
Aug. 1	56	0.3
8	9	0.07
Total or Avg.	40,172	5.8

a/ Traps were in service for a total of 6,883 trap weeks.

Table 16. Results of adult boll weevil surveys in the eradication zone in 1973.[a]

	Trap crop				Farmer cotton			
	Native		Sterile		Native		Sterile	
Week of[b]	No. adults found	No. flds with adults found	No. adults found	No. flds with adults found	No. adults found	No. flds with adults found	No. adults found	No. flds with adults found
May 9	0	0	-	-	0	0	-	-
16	0	0	-	-	0	0	-	-
23	0	0	-	-	0	0	-	-
30	0	0	-	-	0	0	-	-
June 6	1	1	108	40	0	0	15	10
13	5	5	235	89	1	1	14	5
20	0	0	91	38	1	1	26	12
27	1	1	61	36	2	2	16	13
July 4	0	0	3	3	1	1	18	14
11	0	0	5	3	3	3	64	30
18	2	2	3	3	5	4	29	22
25	0	0	2	2	0	0	23	20
Aug. 1	0	0	0	0	6	3	13	9
8	0	0	0	0	0	0	2	2
Total	9	9	508	214	19	15	220	137

a/ Total of 236 fields in the eradication zone.

b/ Through the week of June 27 adults were found by whole plant examination, thereafter they were found during square inspection.

Table 17. Results of detection surveys for possible boll weevil oviposition damaged squares in the eradication zone in 1973.

Week of	Number of Collections a/	Number of Squares
June 13	2	11
20	17	226
27	23	215
July 4	14	105
11	33	474
18	45	590
25	33	491
August 1	12	123
8	4	44
TOTAL	183	2,279

a/ Collections came from a total of 77 individual fields.

Table 18. Results of square dissection and percent field sterility obtained from sterile male releases in the units of the eradication zone, 1973. a/

Unit	No. of Fields With Eggs or Immatures	No. of Immatures	No. of Eggs	No. eggs Hatched	Percent Sterility
		July 9-27			
1	0	0	0	0	100
2	3	0	49	0	100
3	4	25	28	4	50
4	29	186	489	16	69
5	15	13	116	4	87
6	1	0	2	0	100
TOTAL	51	224	682	24	72
		July 30-August 10			
1	0	0	0	0	100
2	0	0	0	0	100
3	1	13	2	2	0
4	6	15	31	8	50
5	6	25	35	12	39
6	0	0	0	0	100
TOTAL	13	53	68	22	38

a/ Square dissection records obtained from E. P. Lloyd and John McCoy, ARS, Boll Weevil Research Laboratory.

Table 19. Total number of fields and acres and number of infested fields and acres in the units of the eradication zone and the week detected, 1973.

	Total no./Unit		Week of										Total Infested	
			7/11		7/18		7/25		8/1		8/8			
July	Fields	Acres	Fields	Acres	Fields	Acres	Fields	Acres	Fields	Acres	Fields	Acres	Fields	Acres
1	31	276	0	0	0	0	0	0	0	0	0	0	0	0
2	40	293	0	0	0	0	0	0	0	0	0	0	0	0
3	42	402	0	0	2	10	2	5	1	5	0	0	5	20
4	45	274	6	37	10[a]	50	5	27	0	0	0	0	21	114
5	41	287	0	0	0	0	4	13	3	18	1	2	8	33
6	37	285	0	0	0	0	0	0	0	0	0	0	0	0
Total	236	1,817	6	37	12	60	11	45	4	23	1	2	34	167

[a] One of these trap crop only.

Table 20. Results of adult boll weevil surveys in the first buffer zone in 1973.

	Trap crop				Farmer cotton			
	Native		Sterile		Native		Sterile	
Week of	No. adults found	No. flds with adults found	No. adults found	No. flds with adults found	No. adults found	No. flds with adults found	No. adults found	No. flds wi adults fou
May 9	6	6	–	–	0	0	–	–
16	1	1	–	–	0	0	–	–
23	1	1	–	–	0	0	–	–
30	0	0	–	–	1	1	–	–
June 6	3	3	1	1	0	0	0	0
13	26	6	34	11	0	0	1	1
20	5	5	4	4	0	0	3	2
27	3	3	5	4	0	0	1	1
July 4	1	1	2	1	5	5	6	5
11	3	3	2	1	10	8	1	1
18	0	0	0	0	7	4	10	8
25	0	0	0	0	3	2	4	4
Aug. 1	0	0	0	0	4	3	3	3
8	0	0	0	0	9	6	4	4
Total	49	29	48	22	39	29	33	29

a/Total of 565 fields in the first buffer zone.
b/Through the week of June 27 adults were found by whole plant examination, thereafter they were found during square inspections.

Table 1. Results of detection surveys for suspect boll weevil oviposition damaged squares in the first buffer zone in 1973.

Week of	No. of Collections[a/]	No. of Squares	No. of Immatures	No. of Eggs
June 20	13	200	16	10
27	18	212	25	40
July 4	18	119	23	31
11	34	186	53	38
18	30	256	51	67
25	39	287	87	56
August 1	49	660	181	57
8	29	152	57	34
TOTAL	230	2,072	493	333

a/ Collections come from a total of 136 individual fields.

Table 22. Results of boll weevil infestation surveys made in the northern portion of the second buffer zone in 1973.

Week of	No. adults found	Avg. no. adults/acre	% ovip. damaged squares
June 13	8	40	-
18	17	65	-
27	22	87	-
July 4	11	a/	4.0
11	5	a/	4.0
18	7	a/	6.0
25	1	a/	1.0
Aug. 1	6	a/	0.1
8	10	a/	2.0

a/ Adult weevils collected during square inapection therefore the average number per acre can not be calculated.

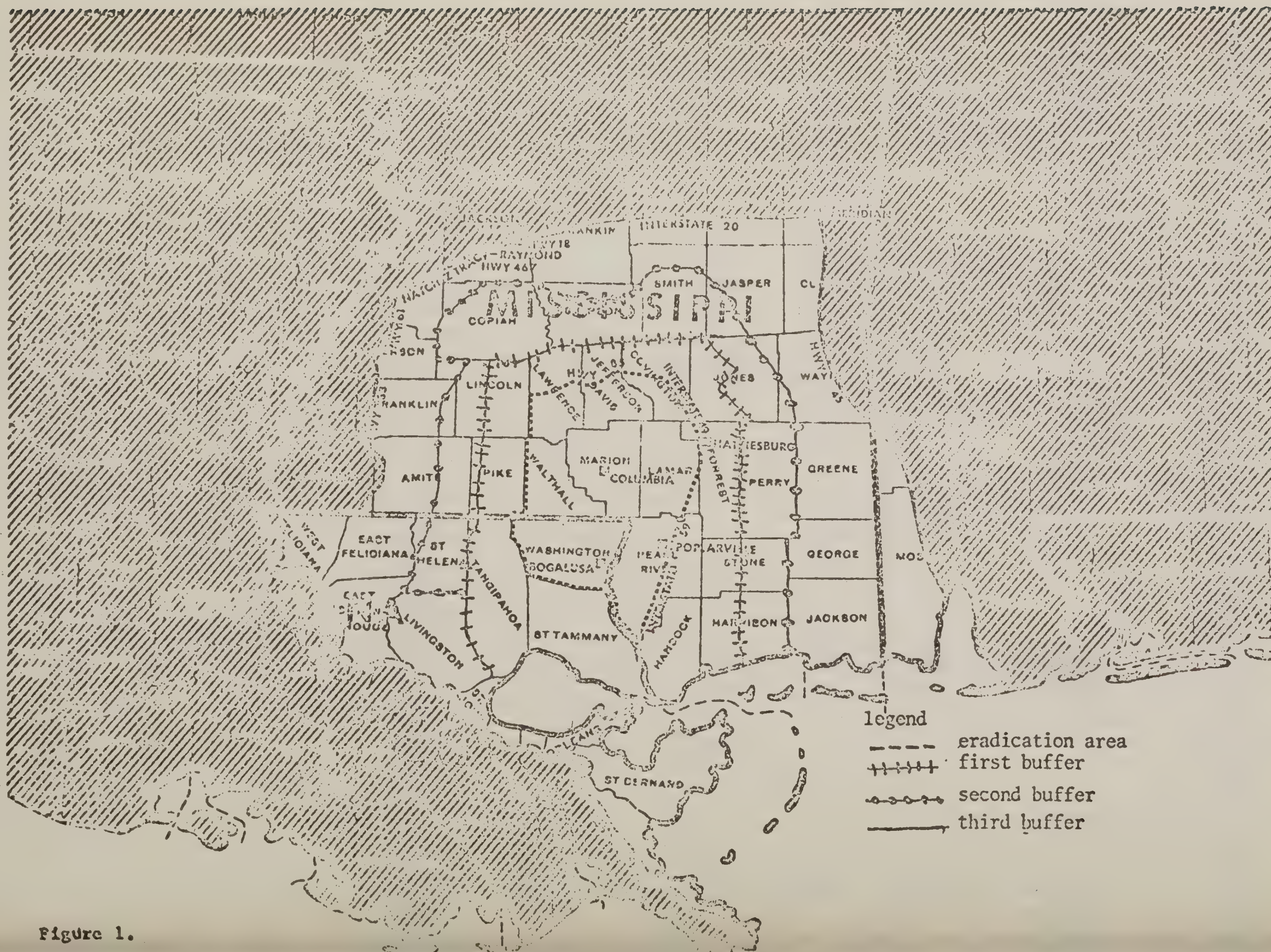

INTERSTATE 20
RAYMOND
HWY 46
SMITH
JASPER
COPIAH
LINCOLN
JONES
FRANKLIN
AMITE
PIKE
WALTHALL
MARION
COLUMBIA
LAMAR
FORREST
PERRY
GREENE
GEORGE
JACKSON
STONE
WASHINGTON
BOGALUSA
ST TAMMANY
TANGIPAHOA
LIVINGSTON
EAST FELICIANA
ST HELENA
HANCOCK
ST BERNARD
legend
eradication area
first buffer
second buffer
third buffer

Figure 1.

WORK UNITS

BOLL WEEVIL ERADICATION TRIALS

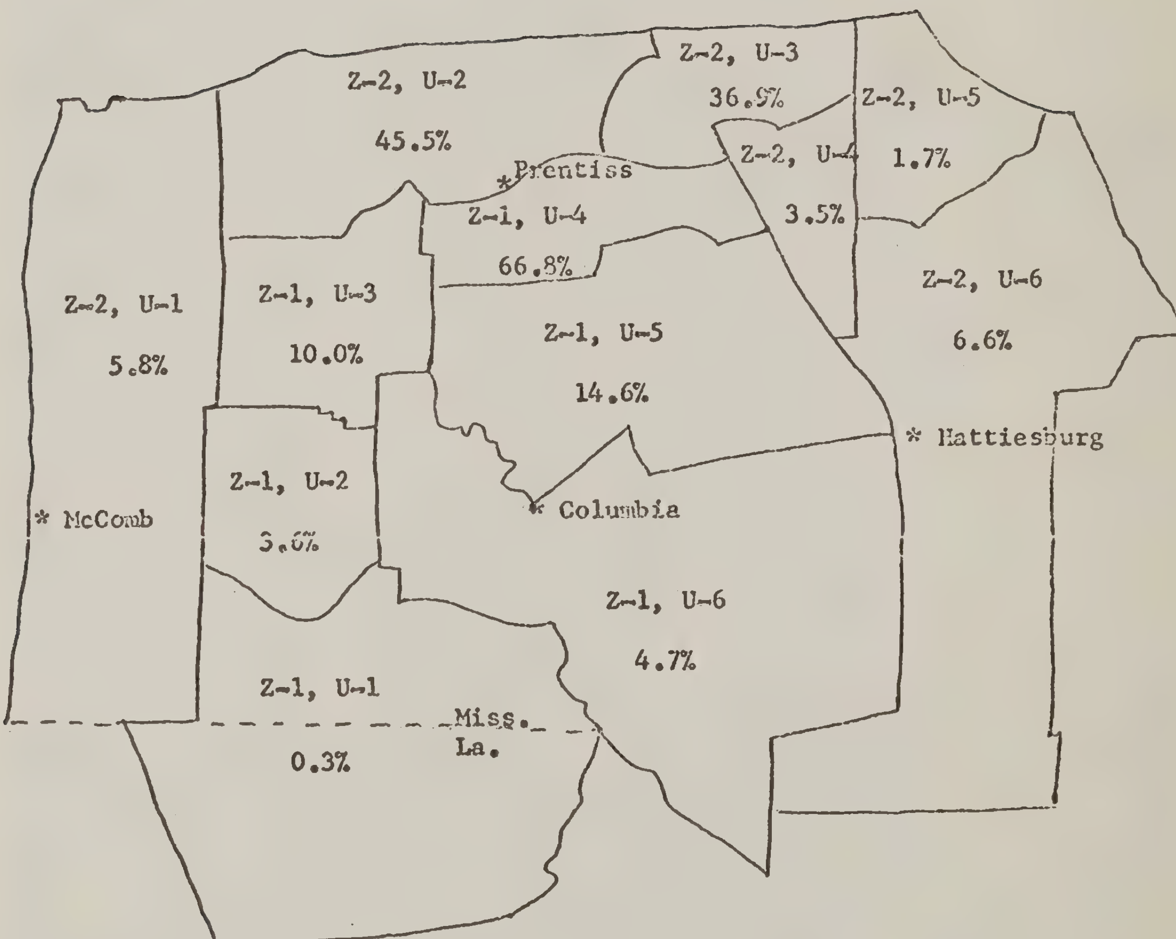


Figure 3. Percent of the total number of boll weevils captured in traps in the various units of the eradication (Z-1) and first buffer (Z-2) zones in 1973.

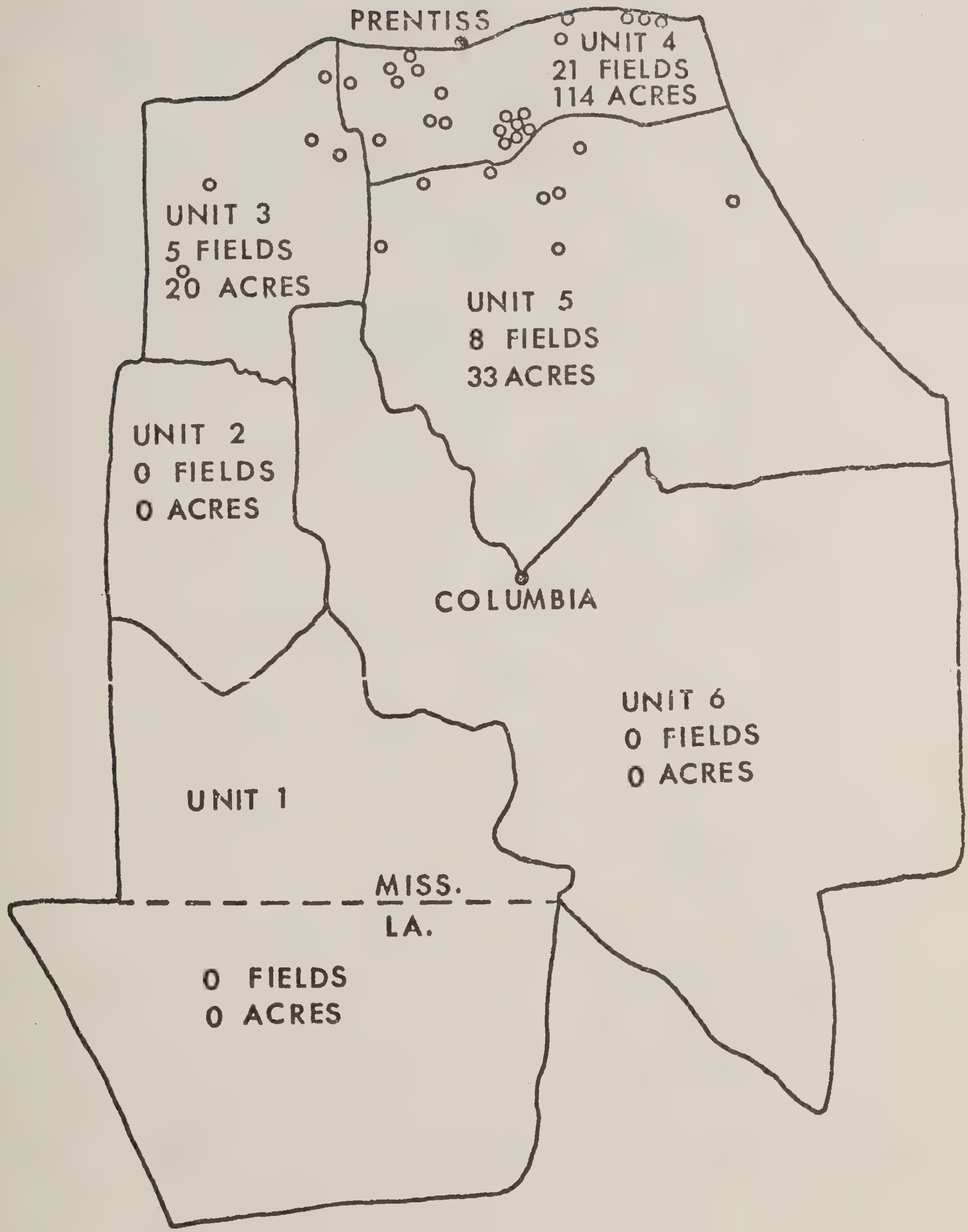


Figure 4. Location and number of boll weevil infested fields and acres detected in the units of the eradication zone in 1973.

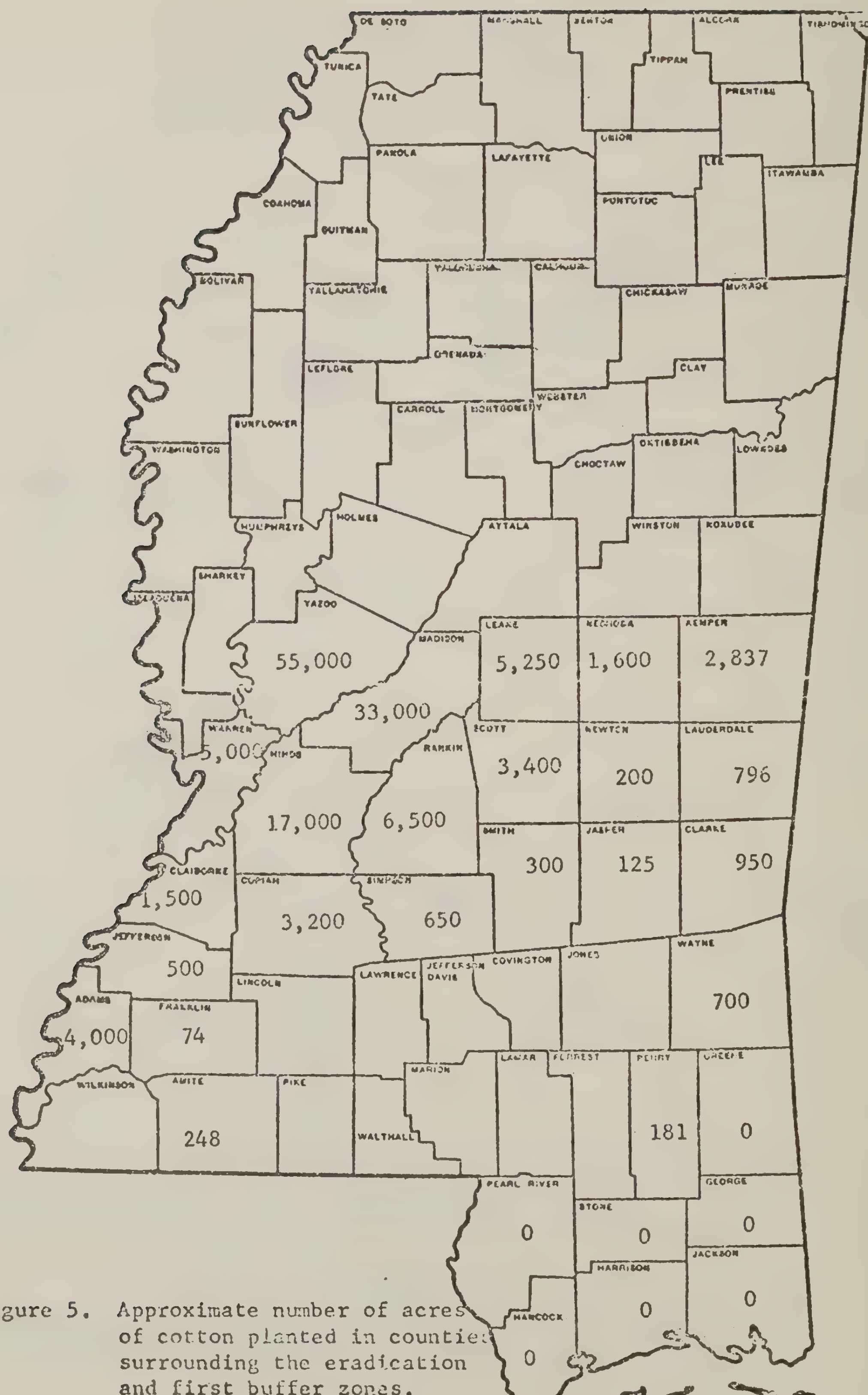


Figure 5. Approximate number of acres of cotton planted in counties surrounding the eradication and first buffer zones.

Addendum 1. Cooperating agencies involved in the Pilot Boll Weevil Eradication Experiment.

Federal - United States Department of Agriculture
Animal and Plant Health Inspection Service
Agricultural Research Service
Cooperative State Research Service
Agricultural Stabilization and Conservation Service

State- Mississippi, Alabama, Louisiana, and Texas
Agricultural Experiment Stations
Cooperative Extension Services (except Texas)
Departments of Agriculture (except Texas)

Cotton Industry - Cotton Incorporated, Raleigh, N.C.
National Cotton Council, Memphis, Tenn.

SPECIAL REPORT

INTENSIVE FIELD SAMPLING IN ERADICATION AND FIRST BUFFER AREAS, PILOT BOLL WEEVIL ERADICATION EXPERIMENT 1973

Prepared By:

E. P. LLOYD, RESEARCH ENTOMOLOGIST

USDA, ARS

BOLL WEEVIL RESEARCH LABORATORY

Mississippi State, Mississippi 39762

Twenty-five fields were selected in the eradication (Zone 1) and first buffer (Zone 2) areas of the Pilot Boll Weevil Eradication Experiment for intensive sampling to detect the presence of low density boll weevil populations in these fields from early June until the experiment was terminated August 10. The secondary objective of this study was to determine the relative abundance of boll weevils in the trap crops and normal plantings as the season progressed. Locations of the 25 fields selected for intensive sampling are shown in Figure 1.

Criteria for evaluation:

The intensive sampling was accomplished with 6 tractor mounted insect collecting machines as shown in Figure 2. These insect collecting machines not only collect adult boll weevils from the plants but infested flared squares as well.

Estimates of the size of the adult populations in the normal plantings can be made by dividing the number of adult boll weevils collected per acre by the average machine efficiency (.65). However, as the season progresses, machine efficiency in collection of adult boll weevils decreases since most of the weevils are inside the bracts of the squares. Since, the machines also collect infested flared squares, estimates of the size of the infesting population of adult boll weevils can be made from the number of infested flared squares by the following computations.

$$\text{No. of adult boll weevils/acre} = \frac{\text{No infested square/acre}}{\text{No. of eggs laid/female/day}} \times \frac{\text{machine}}{\text{efficiency}} \times 2$$

In this equation the number of eggs laid per day/females is used as the divisor since flared squares usually remain on the plant 1 day after the abscission layer is formed prior to shed. Machine efficiency in collecting flared squares is approximately 80% under average field conditions. The equation is multiplied by 2 to account for male as well as female boll weevils, assuming a 50-50 sex ratio.

If 1 infested flared square was collected per acre, the following compulations would be made to estimate the size of the adult boll weevil population.

No. of adults/acre = 1/7 x .8 x 2

= .2 adult weevil/acre

Therefore, if only 1 infested square were collected in an acre sample, the adult population would be estimated to number 1 per 5 acres of cotton. If 1 square were collected on 18 acres of cotton the confidence level would increase to 1 adult weevil per 90 acres of cotton.

The size of the overwintered boll weevil population can be estimated from squares infested by first and second generation weevils assuming a 10-fold rate of increase per generation and an 18 acre sample size as follows:

Size of adult overwintered boll weevil population when 1 infested square is collected per 18 acres of sampling.

Overwintered weevils	Rate of increase	First generation weevils	Rate of increase	Second generation weevils
1/90 acres	X 10	1/900 acres	X 10	1/9000 acres

Interpretation of the size of adult population from collections in trap crops is difficult because weevils have concentrated in the trap crops because of behavior responses to plant size and the presence of the aggregating

pheromone grandlure in the trap crops. While sampling the trap crop presents a difficult statistical problem in estimating the actual size of the populations, it provides a valuable tool if detection is the primary objective. In the case of the experiment reported here, detection (presence or absence) is of primary importance. For this reason, emphasis will be placed on detection rather than precise estimates of the size of the boll weevil population during the period of evaluation.

Sampling procedures:

Since the trap crops were treated with the systemic insecticide aldicarb, the entire trap crop in each of the 25 fields was sampled 5 days each week in each of the 25 fields except when operations were prevented by weather or mechanical failures. Trap crops averaged 1/5 acre in size in each of the 25 fields.

An additional sample, 1 acre in size, was taken each week in the normal plantings from each field. Of the 25 fields selected for intensive sampling, 18 were in the eradication area and 7 in the first buffer area.

Detection of infestations:

Boll weevils were detected in every field sampled in the first buffer area except in Unit 1, field 21, as shown in Table 1. The weevil free location was in Lincoln County (western part of first buffer area) and was not located in close proximity to infested fields as were the other 6 locations. Boll weevil populations were suppressed in the first buffer area to a low level with insecticide treatments. These treatments were terminated about August 10.

Adult boll weevils were detected in 6 of the 18 fields in the eradication (Zone 1) area as shown in Table 2. Boll weevil populations in the 2 northern most fields in Zone 1 (Unit 4, fields 110, and 119) were suppressed with insecticide treatments . Boll weevil infestations detected in the other 4 fields (Unit 3, field 19; Unit 5, field 102; Unit 6, fields 61 and 89) were eliminated with sterile male weevils and/or trap crops or traps. Boll weevils were not detected in the other 12 fields subjected to intensive sampling. All of these were in the southern two-thirds of zone 1.

Of the 10 native adult boll weevils collected in the eradication area, 9 were collected from the trap crops. The native adult boll weevil collected in the normal planting was at field 61 in Unit 6. This field was planted on April 12, the earliest planting in the area. Because of cold weather in April which caused seedling damage, all but 2 acres of this 30 acre field was re-planted in May. The native weevil collected in this normal planting during the last week in June was collected from the 2 acres of the April 12th planting which had survived the adverse weather. In the same collection were 43 sterile male boll weevils. No other native adults or infested squares were detected in the field for the remainder of the season. Since the field was not treated with insecticides, we assume that the population was eliminated with sterile male releases since a native female weevil was collected in the normal plantings

One native female boll weevil was collected on July 12 in a trap crop in Unit 3, field 19. This native female weevil was confined on cotton squares for egg laying. None of the eggs she deposited hatched.

Two infested squares were collected from trap crops during the sampling period. One was collected during the last week in June from Unit 6, field 61. The trap crop only was treated with insecticides. No adult native weevils nor infested squares were detected in this field for the remainder of the sampling period.

The other infested square collected during the week of July 16-20 was from Unit 4, field 110, the northernmost field sampled in the eradication area. Since there was considerable evidence from other sources that migration of weevils had occurred into the northern 1/3 of the eradication area, this field was treated twice weekly with sprays of azinphosmethyl.

Summary and Conclusions:

As shown in Table 2, boll weevil infestations were detected in 6 of 18 intensively sampled fields, all 6 were in the northern 1/3 of the eradication area (Zone 1). Infestations detected in 2 fields were eliminated by insecticide treatments. Infestations detected in 4 fields were eliminated by sterile male releases and/or traps and trap crops. Infestations were not detected in the other 12 fields, all of which were in the southern two-thirds of the eradication area. Boll weevils were not detected in any intensively sampled field in the eradication area (Zone 1) during the last 2 weeks (July 23-August 3) of sampling.

These data indicate strongly that with the intensive sampling techniques used boll weevils were undetectable after 2 generations in the 18 selected fields in the eradication area. Based on confidence in the calculations presented earlier in this report of the detection of weevils, elimination of the boll weevil population is indicated.

Table 1. Intensive machine sampling of trap crops and normal plantings in Zone 2 in the Pilot Boll Weevil Eradication Experiment. 1973. (7 fields)

Date	Trap Crop: No. of Boll Weevils	Trap Crop: No. of infested sqs.	Normal Plantings: No. of Boll Weevils	Normal Plantings: No. of infested sqs.
June 4-8	3 S 1 N a/	0	--	--
June 11-15	23 S 7 N b/	0	1 N b/	0
June 18-22	15 S 5 N c/	3 larvae c/	0	0
June 25-29	8 S 6 N d/	12 larvae d/	6 S 2 N	0
July 2-6	3 S 2 N e/	1 larva e/	2 S 1 N	0
July 9-13	5 S 1 N f/	7 larvae f/	1 S	0
July 16-20	1 S	2 larvae g/	2 S	0
July 23-27	1 N h/	0	1 S	0
July 30 - August 3	1 S	0	2 S 3 N i/	0

a/ Native weevils collected in Unit 4, field 112.

b/ Native weevils collected in Unit 2, field 101; Unit 3, field 119; Unit 4, field 112; Unit 5, field 110.

c/ Native weevils collected in Unit 3, field 119; Unit 4, field 86, and Unit 5, field 110. Larvae were collected in Unit 5, field 110.

d/ Native weevils collected in Unit 3, field 119; Unit 4, field 86, and Unit 5, field 110. Larvae were collected in Unit 2, field 101; Unit 5, field 110, and Unit 6, field 5.

Table 1.- Continued.

e/ Native weevils collected in Unit 4, fields 86 and 112. Larvae collected in Unit 2, field 101.

f/ Native weevil collected in Unit 5, field 110. Larvae collected in Unit 2, field 101, and Unit 3, field 119.

g/ Larvae collected in Unit 2, field 101.

h/ Native weevil collected in Unit 2, field 101.

i/ Native weevils collected in Unit 2, field 101, Unit 3, field 119, and Unit 4, field 112.

Table 2. Intensive machine sampling of trap crops and normal plantings in Zone 1 in Pilot Boll Weevil Eradication Experiment 1973. (18 fields)

Date	Trap Crop		Normal Plantings	
	No. of Boll Weevils	No. of infested sqs.	No. of Boll Weevils	No. of infested sqs.
June 4-8	29 S	0	---	---
June 11-15	303 S 6 N[a/]	0	19 S	0
June 18-22	312 S 1 N[b/]	0	43 S	0
June 25-29	222 S 2 N[c/]	1 larva[c/]	54 S 1 N[c/]	0
July 2-6	84 S	0	10 S	0
July 9-13	21 S 1 N[d/]	0	9 S	0
July 16-20	6 S	1 larva[e/]	12 S	0
July 23-27	4 S	0	2 S	0
July 30 - August 3	4 S	0	0	0

a/ Native weevils collected Unit 3, field 19; Unit 4, fields 110 and 119; Unit 5, field 102, Unit 6, fields 61 and 89.

b/ Native weevils collected in Unit 6, field 89.

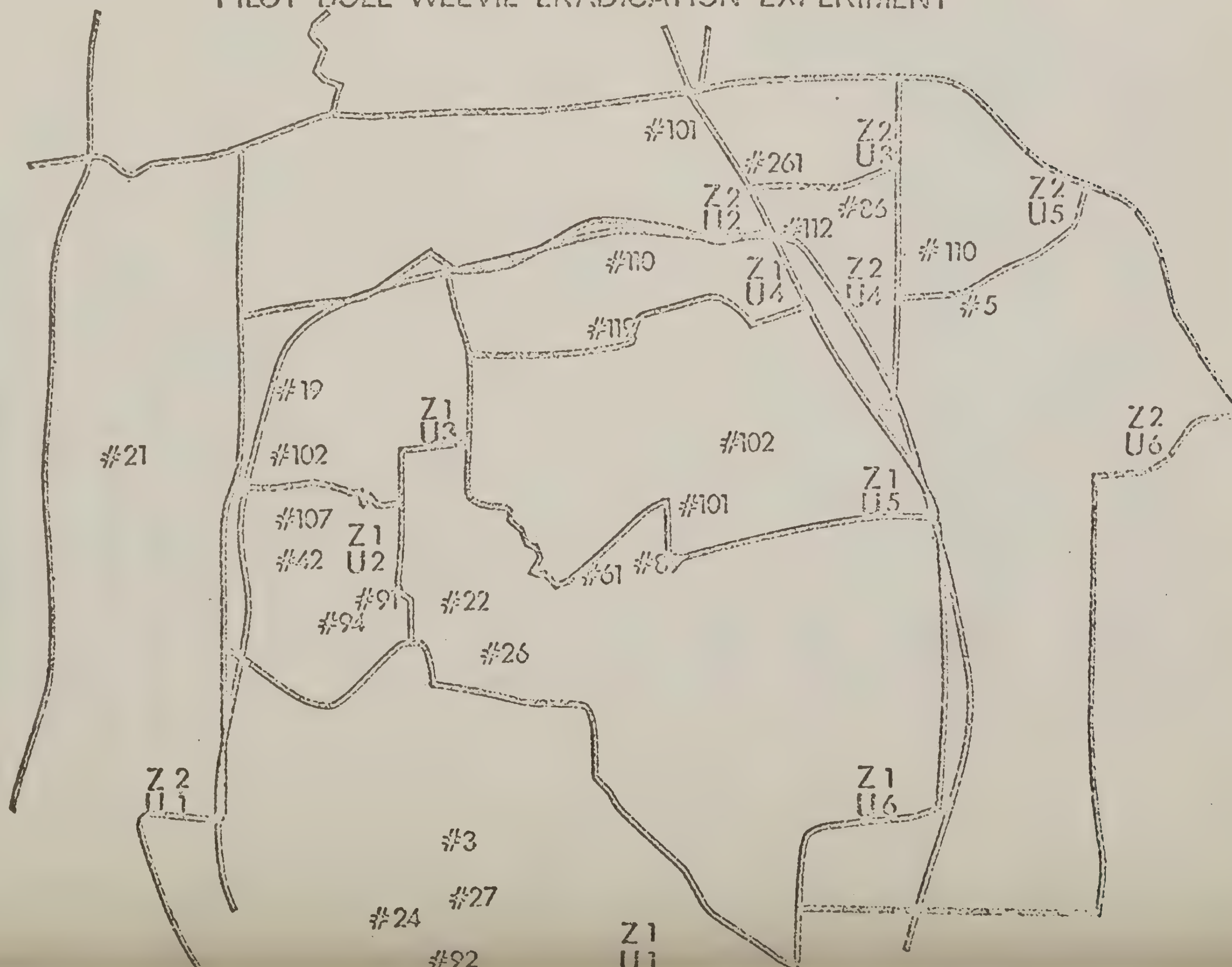
c/ Native weevils collected in Unit 4, field 110; and Unit 6, fields 61 and 89; larva collected in Unit 6, field 61.

d/ Native weevil collected in Unit 3, field 19

e/ Larva collected in Unit 4, field 110.

FIGURE 1. LOCATION OF FIELDS SAMPLED INTENSIVELY IN ZONE, 1 & 2 IN 1973

PILOT BOLL WEEVIL ERADICATION EXPERIMENT



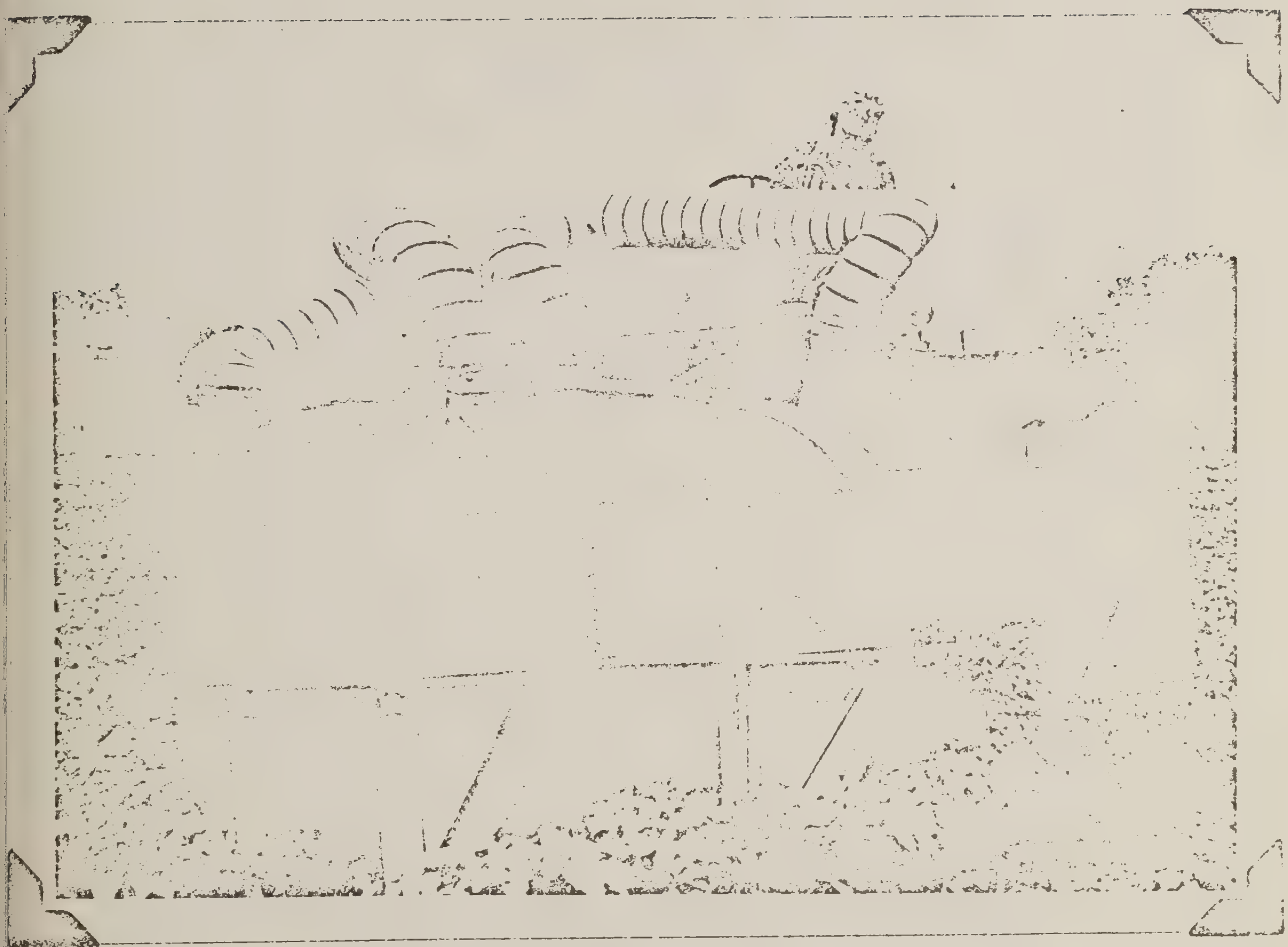


FIGURE 2. McCOY INSECT COLLECTING MACHINE USED IN INTENSIVE SAMPLING, PILOT BOLL WEEVIL ERADICATION EXPERIMENT. SOUTHERN MISSISSIPPI, 1973.

SPECIAL REPORT

RELATIVE POPULATIONS AND SUGGESTED LONG-RANGE MOVEMENTS OF BOLL WEEVILS THROUGHOUT THE AREA OF THE PILOT BOLL WEEVIL ERADICATION EXPERIMENT AS INDICATED BY TRAPS IN 1973

Prepared By:

W. H. CROSS, RESEARCH ENTOMOLOGIST

USDA, ARS

BOLL WEEVIL RESEARCH LABORATORY

Mississippi State, Mississippi 39762

Relative Populations and Suggested Long-Range Movements of Boll Weevils Throughout the Area of the Pilot Boll Weevil Eradication Experiment as Indicated by Traps in 1973.

During 1973, Leggett traps were used extensively for survey of native overwintered and subsequent generations of the boll weevil throughout the area of the Pilot Boll Weevil Eradication Experiment (PBWEE) to indicate relative population levels and long-range movement in the different zones. Trap sites were located in radiating lines at 5-mile intervals from Morgantown near the center of the core (Zone I). Some changes in trap sites were made during the year. During April, sites were located in Zones III, IV, V, and the northeast corner of II. By May 2, 40 sites were established 1 or more miles from cottonfields and 32 adjacent to 1972 or 1972/73 cottonfields. During May, 27 additional non-cottonfield oriented sites were located in or near Zones I and II. Through August 1, these 99 sites each included 10 traps (placed 20-35 feet apart in a row) which were checked for weevils and rebaited with grandlure weekly.

After August 1, the number of traps per site was reduced to 5, sites in Zones IV and V were eliminated, 2 sites were moved a mile from 1973 cotton, and about 8 new sites were added. This resulted in 60 non-cottonfield oriented sites in the revised grid. Then beginning August 22, 29 additional sites were located to 75 miles south of Morgantown along each side of the Pearl River.

During the year, APHIS operated traps around 1972, 1972/73, or 1973 cottonfields as follows: 2850 in Zone I, 4679 in Zone II, and 561 in Zone III. Numbers of boll weevils captured per 10 traps and averaged by units

in these zones were compared with captures by the above trap sites. Maps were prepared showing the total numbers of boll weevils captured at each site each week beginning April 11. For the purpose of the present report it seems adequate to depict captures for the following more critical periods:

May 16 - 23 - - - - - - - Figure 1

June 6 - 13 - - - - - - - Figure 2

July 4 - 11 - - - - - - - Figure 3

July 25 - Aug. 1 - - - Figure 4

Aug. 1 - 8 - - - - - - - Figure 5

Aug. 15 - 22 - - - - - - Figure 6

Sept. 12 - 19 - - - - - - Figure 7

<u>May 16 - 23</u>: Emergence of overwintered boll weevils was well advanced with higher numbers being captured by sites at 1972 cottonfield locations. Small numbers of adults were captured by APHIS traps only in units 3-6 in Zone I and units 2-6 in Zone II. However, no captures throughout Zone I and all but the northeast corner of Zone II by non-cottonfield oriented traps suggested little long range movement into the area by this period.

<u>June 6 - 13</u>: A peak in emergence of overwintered weevils was indicated by trap captures and many non-cottonfield oriented sites in Zones III, IV, and V captured large numbers of weevils suggesting considerable movement away from 1972 fields. Most interesting were the high numbers captured by APHIS traps in north central Zone III and the decreasing gradient of captures into Zone I especially to the south of this highly infested area in Zone III.

<u>July 4 - 11</u>: Trap captures in all areas were reduced; this is typical of the period of the year during reproduction of the boll weevil. Only 5 weevils were captured in Zone I and 3 in Zone II by non-cottonfield oriented traps.

July 25 - August 1: Captures were further reduced at almost every site, non-cottonfield sites in Zones I and II were all negative, and APHIS traps indicated only a trace of adult weevils in units 2 and 4 in Zone I and units 2 and 3 in Zone II.

August 1 - 8: Sites in Zone I were still negative but beginning of fall migration was indicated by captures in Zone II.

August 15 - 22: Considerably increased overall captures and a clear gradient of decreasing captures into the center of Zone I suggested long range movement from outside especially from north central areas.

September 12 - 19: In this week, peak captures occurred during the fall migratory period; a gradient was still evident into the center of Zone I of the PBWEE; and movement even south of Morgantown was shown by the newly located line of traps along the Pearl River.

It is concluded that at least most of the adult boll weevils captured by non-cottonfield oriented traps in Zone I during June and again in August were migrants from outside the area. This is supported by the negative captures before both of these periods and the gradient of decreasing captures toward the center of Zone I during the periods. Of more interest, however, is that 28 non-cottonfield sites in Zones I and II captured no weevils during the last week in July while in the same period 11 of 38 non-cottonfield oriented sites in Zones III, IV, and V captured weevils.

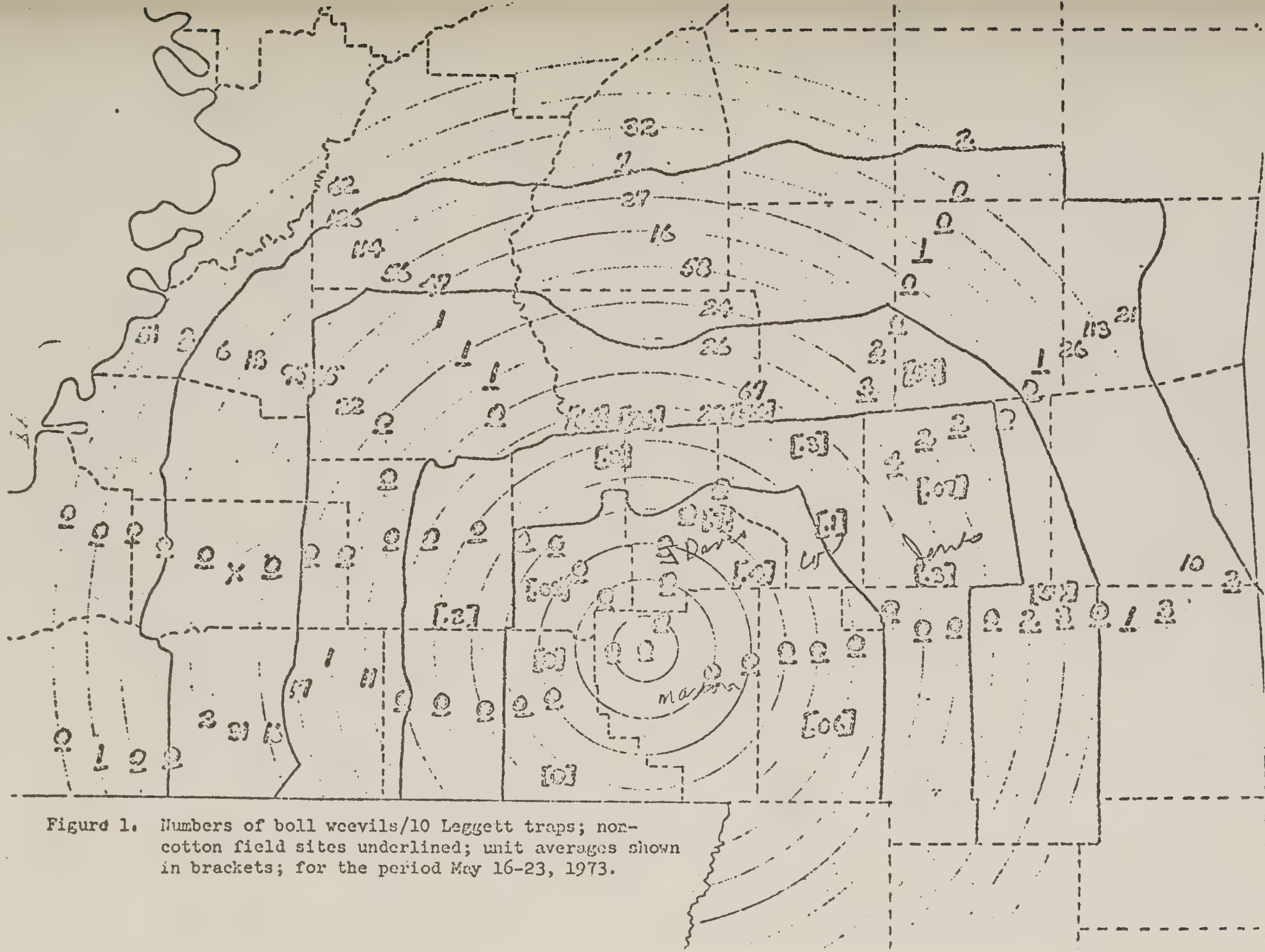


Figure 1. Numbers of boll weevils/10 Leggett traps; non-cotton field sites underlined; unit averages shown in brackets; for the period May 16-23, 1973.

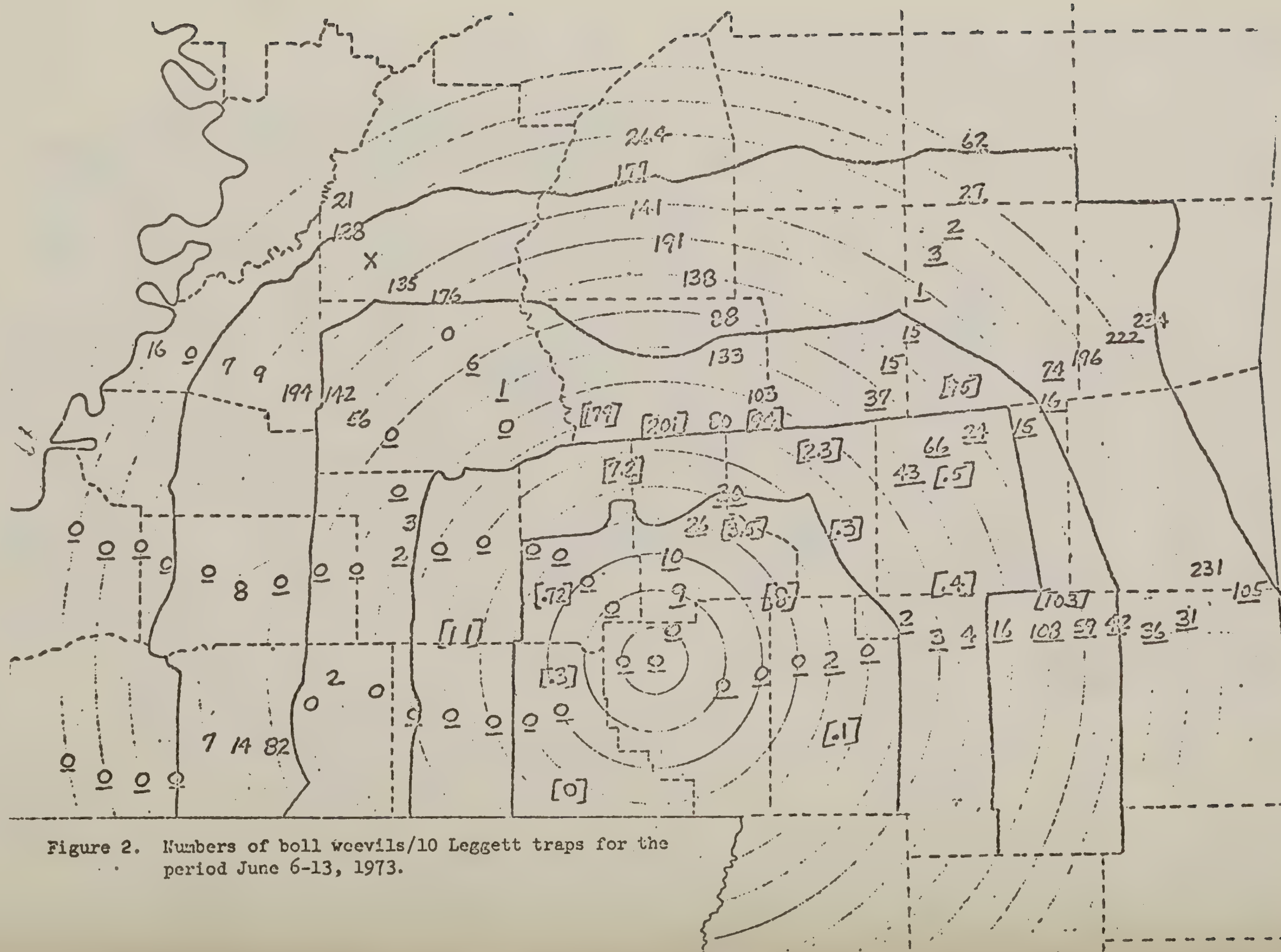


Figure 2. Numbers of boll weevils/10 Leggett traps for the period June 6-13, 1973.

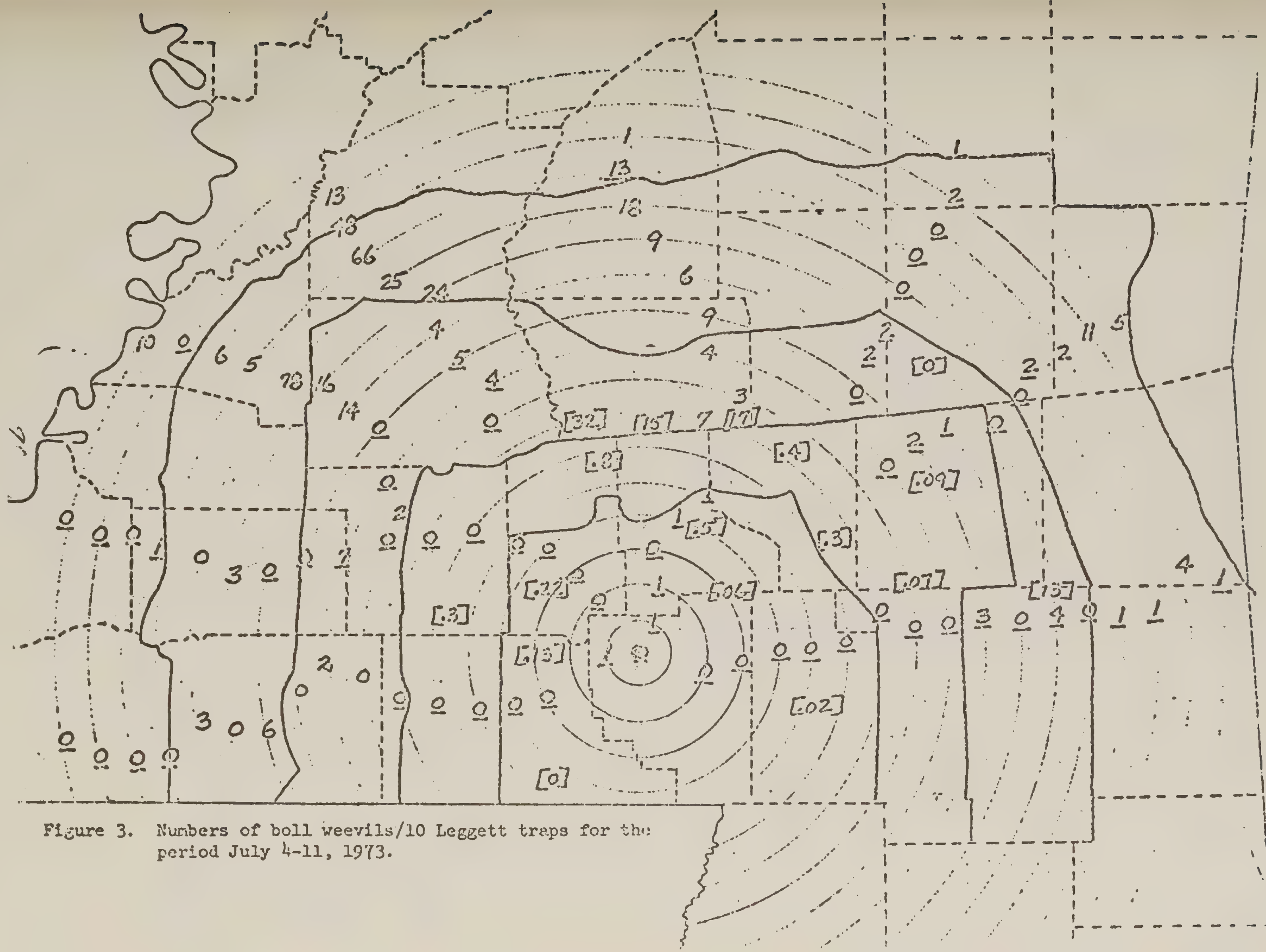


Figure 3. Numbers of boll weevils/10 Leggett traps for the period July 4-11, 1973.

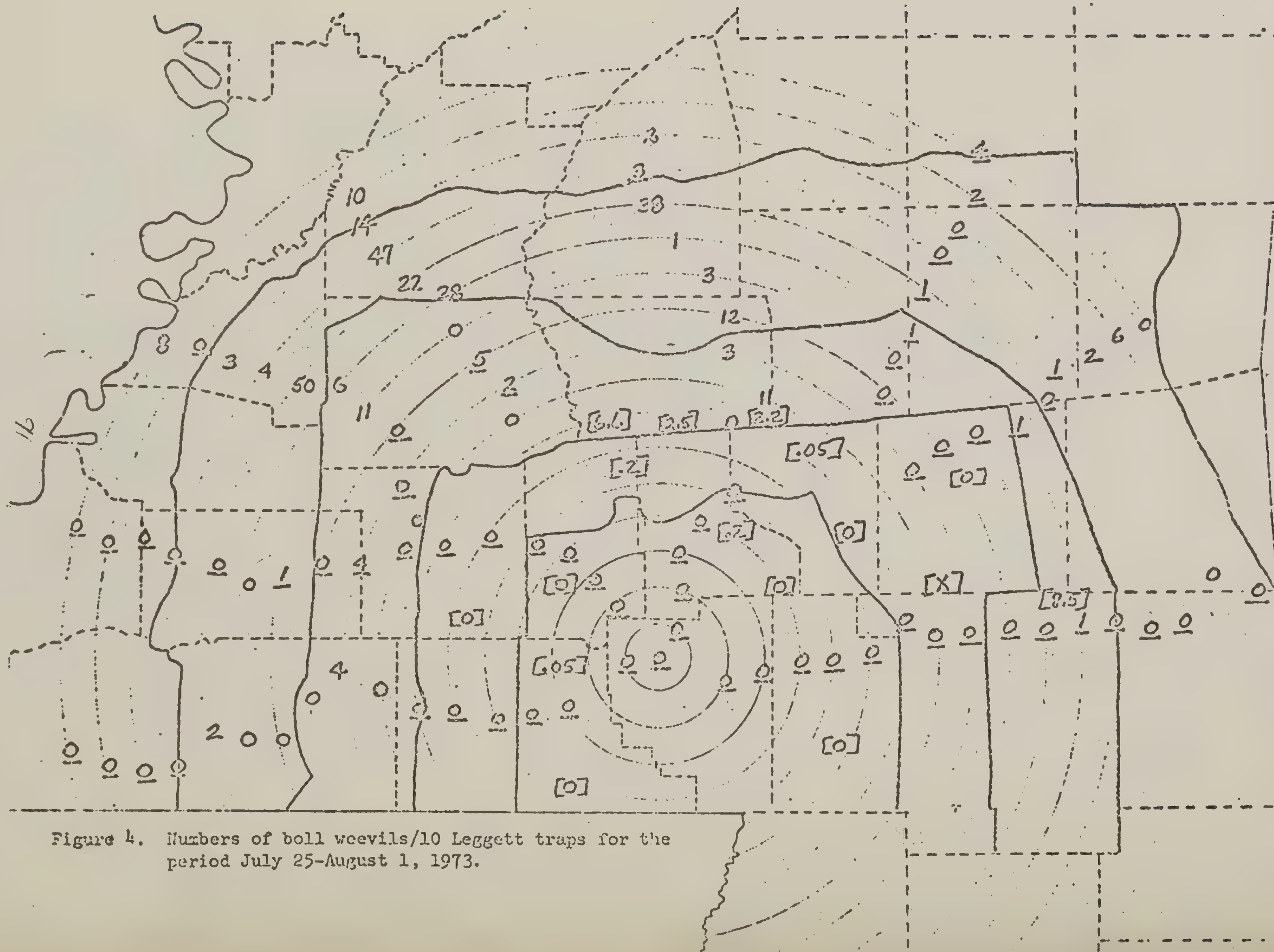


Figure 4. Numbers of boll weevils/10 Leggett traps for the period July 25-August 1, 1973.

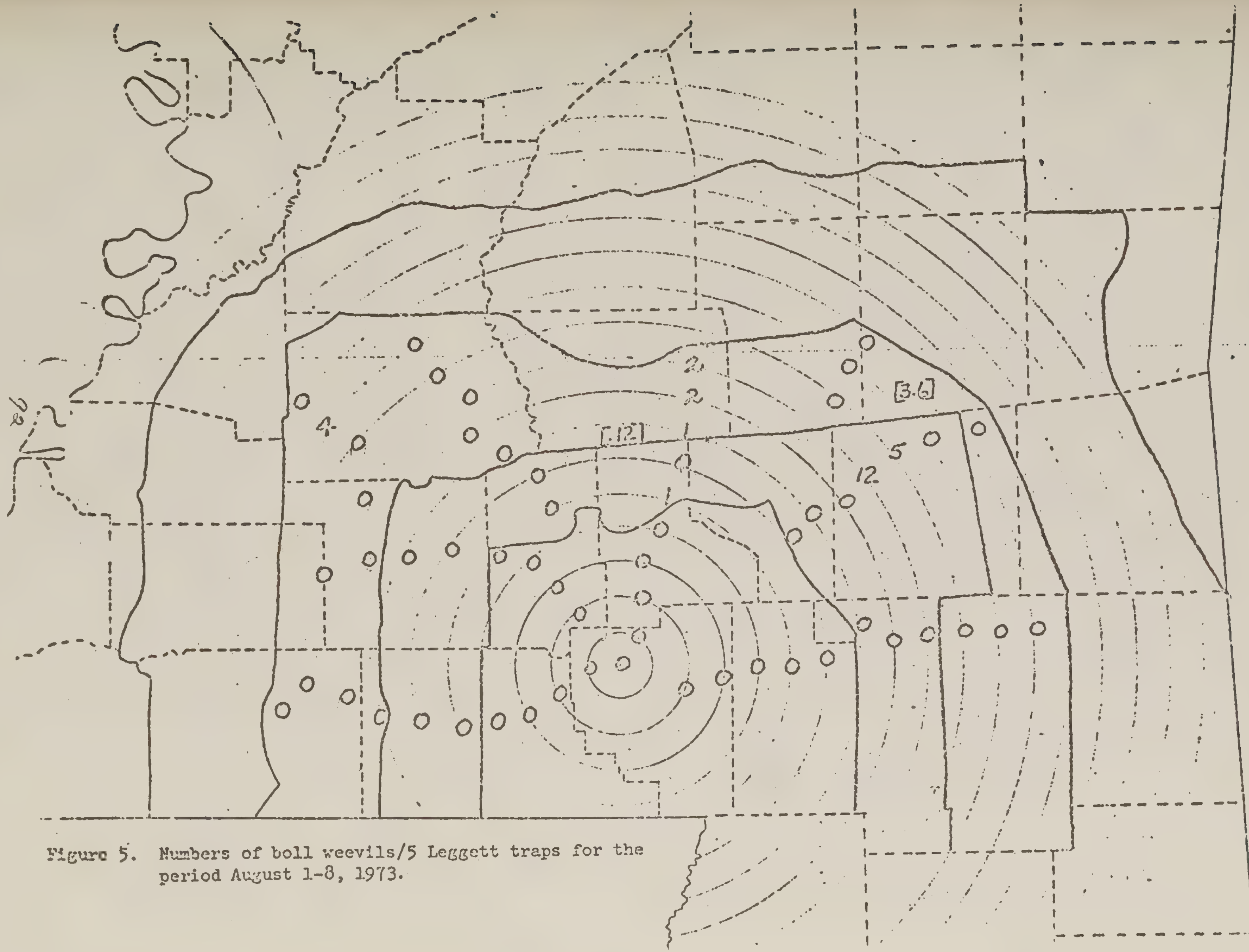


Figure 5. Numbers of boll weevils/5 Leggett traps for the period August 1-8, 1973.

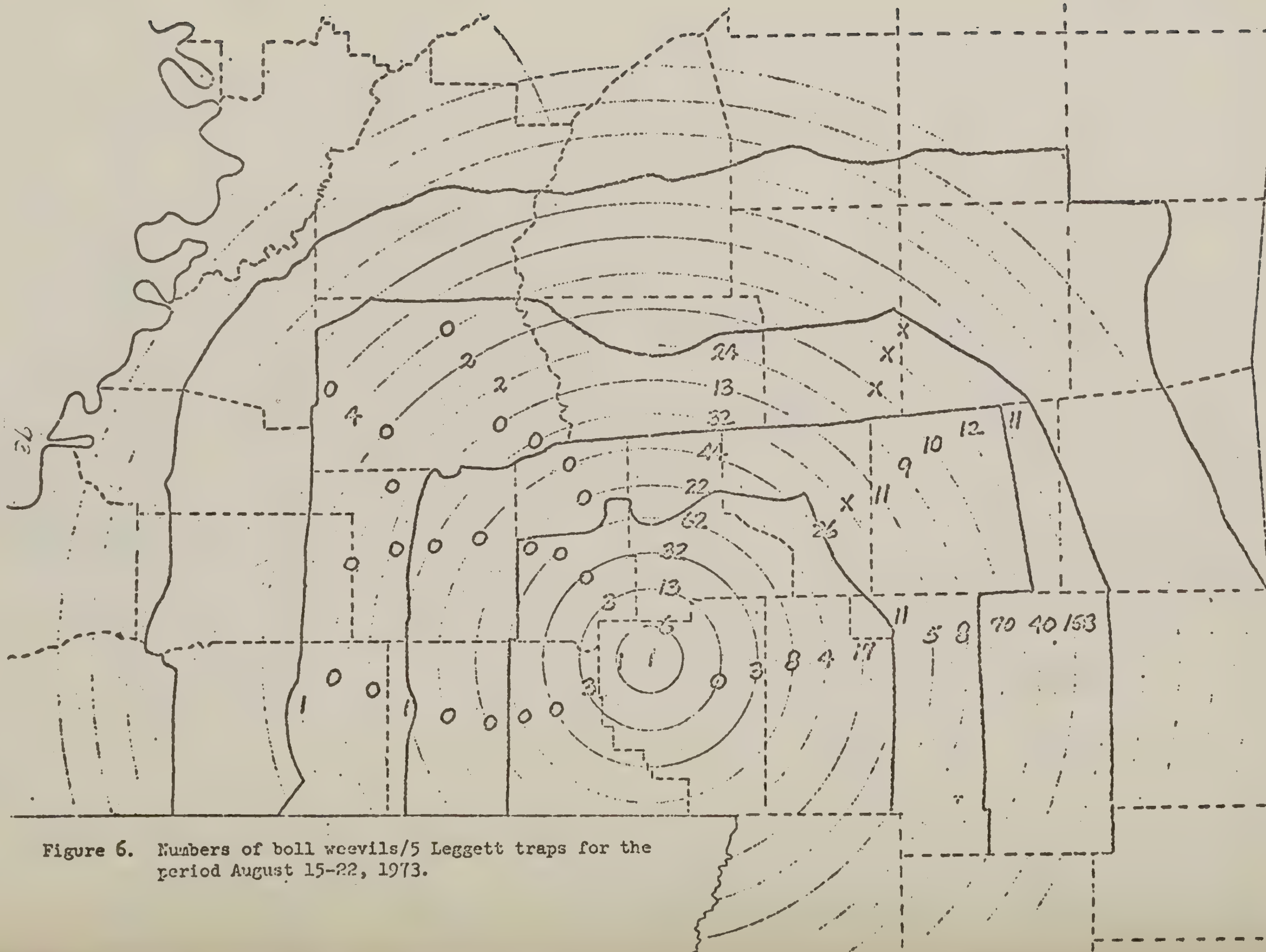


Figure 6. Numbers of boll weevils/5 Leggett traps for the period August 15-22, 1973.

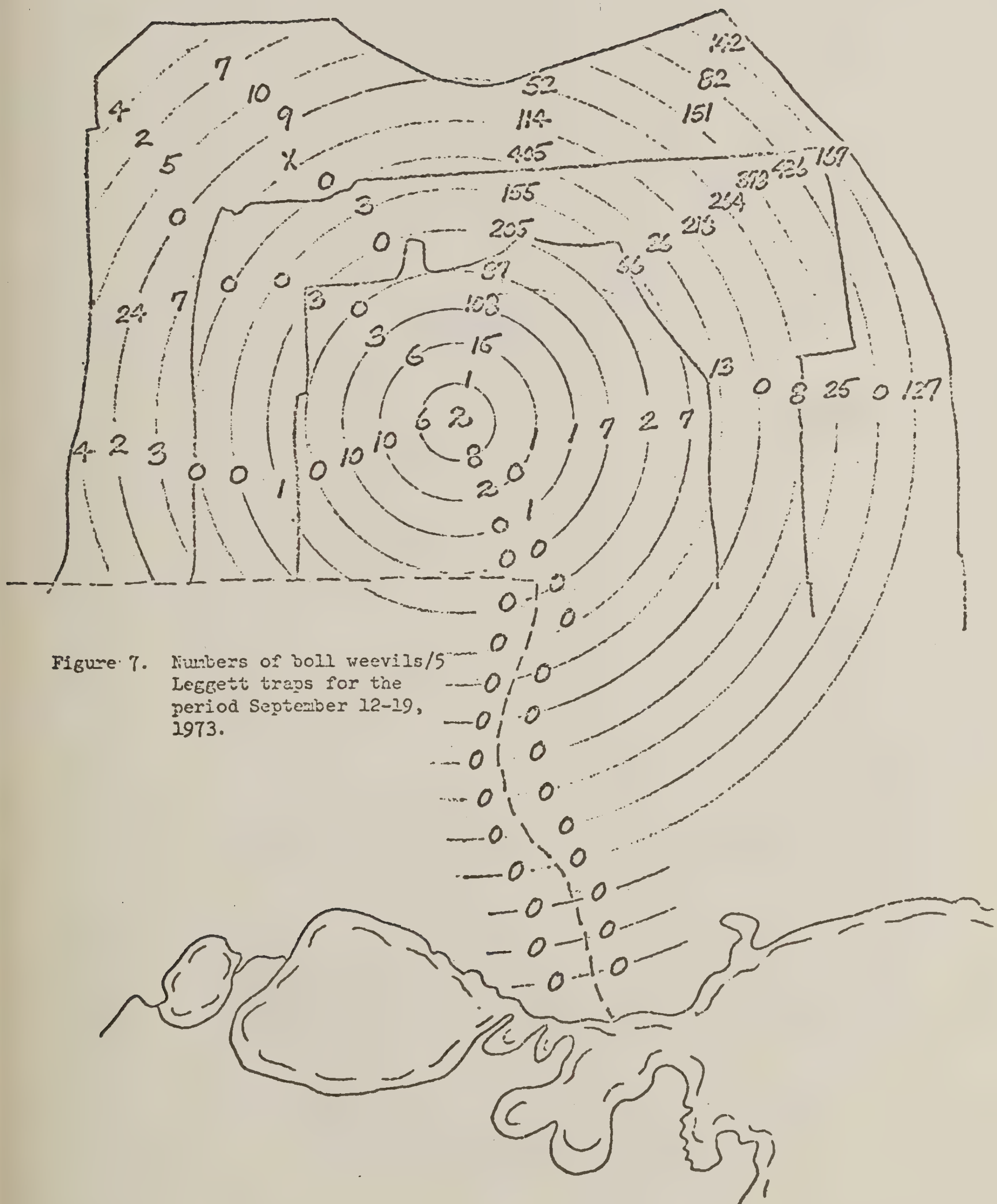


Figure 7. Numbers of boll weevils/5 Leggett traps for the period September 12-19, 1973.

Addendum 4.

SPECIAL REPORT

USE OF IN-FIELD TRAPS BAITED WITH GRANDLURE

IN THE PILOT BOLL WEEVIL ERADICATION

EXPERIMENT IN 1973

Prepared by:

D. D. HARDEE, RESEARCH ENTOMOLOGIST

USDA, ARS

BOLL WEEVIL RESEARCH LABORATORY

Mississippi State, Mississippi 39762

Leggett traps, baited with the synthetic pheromone of the boll weevil, grandlure, at the rate of 1-2 traps/acre of cotton were placed around the periphery of cotton fields in Zones I and II as one of the suppression measures in the Pilot Boll Weevil Eradication Experiment (PBWEE). Because of the necessity of placing peripheral traps out of the way of normal farmer operations, their effectiveness is sometimes reduced from interference of weeds, grass, and trees with reflectance of colored traps and proper diffusion of pheromone via wind movements away from the trap. A second problem with peripheral traps is that after boll weevils have entered fruiting cotton fields, they do not move out of the fields and respond to sources of grandlure placed around the edge of the field. Because of these factors, the question was raised in early 1973 (E. F. Knipling, private communication) as to the effectiveness of a small, grandlure-baited trap placed inside the cotton field ("in-field traps") in a manner not to interfere with regular farming practices. Subsequently, a small in-field trap was designed and evaluated at several locations, including Zones I and II of the PBWEE. The traps were constructed of tapered 0.5 l soda cups about 10-cm tall (6.2-cm bottom diam., 8.75-cm top diam.) painted Saturn^R yellow and topped with a screen cone fastened to the cup with brass paper fasteners and with a 5 mm hole in the apex of the cone which opens into a 5-cm^3 plastic box (0.6 to 1.2 cm base). Ten to 12 triangular holes cut in the top of the cup allows passage of responding weevils from the cup upward between the screen and the cup into the plastic box. The traps were baited weekly with a cigarette filter impregnated with 3 mg grandlure.

Part I. Detection of Boll Weevils in Infested Fields in Zone I.

As reported in an earlier section of this report, 32 fields on the northern edge of the eradication area were infested with boll weevils. These fields were treated with insecticide at 3-day intervals from the time of detection (after July 13) until the experiment was terminated on August 10. Intensive field inspections after 2 weeks of treatment with insecticides did not detect either adults or infested squares. At this time, in-field traps were installed in 4 of these 32 fields in an effort to detect adult weevils. These fields are identified as fields 16, 17, 23, and 41 of Zone I, Unit 4.

During the morning of July 30, 8-16 in-field traps were placed in the tops of cotton plants in a systematic manner (3-4 traps 60-100 ft apart on every 20th row at 4 points across the field) and baited once or twice weekly thereafter. History of the 4 fields prior to placement of in-field traps, as well as results of captures of boll weevils in in-field traps, are presented in Table 1.

During the 2 weeks prior to the official termination of the PBWEE on August 10, Leggett traps failed to detect evidence of boll weevils in the 4 fields listed in Table 1. (Note: Because of budgetary limitations, about 1/2 of the total number of Leggett traps was operated during the week of July 30; none was operated during the week of August 6.) Visual surveys detected egg-punctured squares in field #41 during the week of July 30 and in field #17 during the week of August 6. In-field traps captured native boll weevils, however, in fields 23 and 41 during the week of July 30, and in fields 16, 23, and 41 during the week of August 6. No boll weevils or signs of boll weevils were detected in field #16 in either week. Since no boll weevils were detected in traps placed on dispersal lines into Zone I (see W. H. Cross, Special Report) during the weeks of July 30 and August 6, which is assumed evidence of no dispersal into

the area at this time of the year, the conclusion was drawn that the in-field traps in operation in Zone I at this time were extremely effective in detecting low populations of native boll weevils. In the case of fields 23 (both weeks) and 41 (week of August 6), the in-field traps detected populations of boll weevils too low for detection by manual surveys.

Part II: Detection and Suppression of Boll Weevils in Selected Fields in Zone II

In Northeast Covington County, Mississippi (Zone I, PBWEE), 4 fields, 2 in each of 2 areas, were selected to place 5 and 10 traps/acre in 1 field each on June 13. These 4 fields fell into 3 general categories. Two fields (62 and 165) were planted late (June 7-9) and began squaring in late July; the other 2 fields were planted in late April and began fruiting in early June. One of these early planted fields (157) was not treated with insecticide while the other (156) received insecticide treatments on a weekly schedule. Initial placement of all traps on June 13 was on the ground in the cotton row, but during the week of July 9 1/2 of the traps were placed in the tops of cotton plants. On June 13 the cotton was just emerging in 2 of the fields (fields 62 (4 acres) and 165 (4 acres)) but was squaring in the other 2 fields (fields 156 (6 acres) and 157 (3 acres)). As shown in Table 2, boll weevils were captured in in-field traps in all 4 of these fields. The captured weevils were sexed throughout the season and infestation counts were made near the traps and at random throughout the field. When possible, females were dissected to determine if they had mated prior to responding to the traps.

Some general conclusions were drawn from the data in Table 2, as well as from other data not given and from general observations. The in-field traps,

whether on the ground in early season or in the tops of plants in mid-to late-season, were not damaged nor did they interfere with regular farming practices by the growers. The general infestation was extremely low during most of the season, but the infestation was generally higher near the traps than over the remainder of the field. Weevils responded to the traps on the ground, but the captures increased to the traps that were placed up on the plants as compared to the ones left on the ground. However, on July 18, 5 virgin females were captured in traps on the ground in cotton over 40 in. tall. On this date 11 of 12 females dissected had not mated prior to responding to traps. These results, as well as those in Table 1, indicate primarily a true sex pheromone response of the females to grandlure-baited in-field traps in mid-season, rather than the aggregating response of both sexes obtained at other times of the year.

As shown in Table 2, visual field surveys (inspection of 200 squares/field/week) failed to detect boll weevil infestations, except on 3 inspection dates, in all 4 fields. In the 2 late planted fields (fields 62 and 165) boll weevils were captured on presquaring cotton with in-field traps from June 11-July 16. Since reproduction could not have taken place in these fields at this time, it is assumed that these were weevils which had emerged from overwintering sites at these fields or migrated from the second buffer area. One additional weevil was collected in field 165 on July 30 after plants began fruiting. These data indicate that in-field traps on late fruiting cotton provided effective suppression of the boll weevil populations.

In the early planted fields, one was treated weekly with insecticide, while the other was untreated. While the differences in square infestation counts between the 2 fields were small, the infestation counts were smaller in the

field (156) which received the insecticide treatments. In fact, an infestation of 0.5% puncture was detected only on July 16. All other infestation counts were negative. (The difficulty of detecting low level populations by square collections should be noted. Based on Poisson distribution functions, the collection of 200 squares/10 acres of cotton has about 2 chances in 1000 of detecting 2 boll weevils on 10 acres of cotton at peak squaring.) In the field (157) which received no insecticide treatments, infestation counts of 4% and 2% were observed on July 3 and 30, respectively. Other square infestation counts in this field were negative. Two Leggett traps around field 156 did not capture any boll weevils during the time in-field traps were in operation, whereas the latter captured 134 weevils (132 females, 2 males) between July 23 and August 10 while the field was being sprayed weekly with a ground-operated, high clearance sprayer. Failure to capture any boll weevils in peripheral Leggett traps suggests that dispersal was not occurring at this time and weevils captured in the field were being produced in the fields where they were captured. Dissection of live weevils (many had died in traps before removal) indicated that they were predominately unmated female weevils. These preliminary data indicate that in-field traps are an effective suppression measure against low density boll weevil populations and are a sensitive detection method for low-density populations. In-field traps combined with insecticide treatments appear to be even more effective. Additional research is needed to evaluate further this new trapping system, alone and in combination with insecticides, for suppression, elimination, and detection of boll weevil populations.

Table 1. Infestation and traps records in selected fields (Zone I, Unit 4, PIUEE) containing in-field traps.

Field No.	Acres in field	No. Leggett traps a/	Boll weevils capt. in Leggett traps	Infestation Record: Week of	Infestation Record: Weevil form observed	Dates insecticide applied	In-field Traps a/: No. in field	No. weevils capt.: July 30	No. weevils capt.: Aug. 6
16	1	3	2 (1 on 6/25) (1 on 7/2)	---	None	None	12	0	1 N♂
17	6	6	0	7/2 7/9 7/16 8/6	Egg-pct. sq. Egg-pct. sq. Egg-pct. sq. Egg-pct. sq.	7/13 7/24 7/27 8/3	8	0	0
23	4	5	4 (2 on 6/12) (2 on 6/25)	7/9 7/16 7/23	Egg-pct. sq., Larvae Larvae Larvae	7/12 7/27 7/16 7/30 7/20 8/3 7/23 8/6	16	2 N♂, 13 N♀	1 E♂, 4 N♀
41	5	3	0	7/16 7/23 7/30	Larvae Egg-pct. sq. Egg-pct. sq.	6/27 b/	16	5 N♀, 1 E♂, 1 E♀	4 N♀, 1 E♂

a/ Because of budgetary limitations, about 1/2 of the total number of Leggett traps was operated during the week of July 30; none was operated during the week of August 6. N=native; E=ebony (laboratory reared).

b/ Dates of additional applications were misplaced.

Table 2. Capture of boll weevils in in-field traps in a low infestation area (Zone II, Covington County, Pilot Boll Weevil Eradication Experiment).

Week	No. native weevils (M - male; F - female) captured in field											
	156[a] (10 traps/A)			157 (5 traps/A)			62 (5 traps/A)			165 (10 traps/A)		
			No./A or[b]			No./A or[b]			No./A or[b]			No./A or[b]
of	M	F	% infest.	M	F	% infest.	M	F	% infest.	M	F	% infest.
June 11	0	2	0	0	1	0	0	0	0	0	0	0
18	4	7	0	1	1	0	0	1	0	1	0	0
25	0	5	0	0	1	0	0	1	0	2	4	0
July 3	0	8	0	0	0	4	0	0	0	0	0	0
9	0	1	0	0	0	0	0	1	0	0	1	0
16	1	12	0.5	0	1	0	0	1	0	0	0	0
23	0	14	0	0	1	0	0	0	0	0	0	0
30	2	45	0	1	13	2	0	0	0	0	1	0
Aug. 6	0	73	0	1	15	0	0	0	0	0	0	0

a/ Field 156 received insecticide applications on June 8, July 19, 24, 31, and August 8. None of the other 3 fields was treated. Fields 156 and 157 were planted May 1; fields 62 and 165 were planted June 7-9.

b/ No weevils were detected in row counts averaging 400 feet weekly. All data given are % egg-punctured squares of the 300-600 squares examined weekly.

MISSISSIPPI DEPARTMENT OF AGRICULTURE AND COMMERCE
DIVISION OF PLANT INDUSTRY
P. O. Box 5207
Mississippi State, Mississippi 39762

Functions of the Division of Plant Industry, Mississippi Department of Agriculture and Commerce in Connection With the Pilot Boll Weevil Eradication Experiment During the Fiscal Year July 1, 1971 Through June 30, 1972 and July 1, 1972 Through June 30, 1973

On July 1, 1971, a Boll Weevil Quarantine was adopted by the Advisory Board of the Division of Plant Industry, Mississippi Department of Agriculture and Commerce, to govern the movement of regulated articles within or through the area covered by the Pilot Boll Weevil Eradication Experiment. On July 2, 1971, notice of the adoption of the quarantine was sent to 50 radio and television stations and 50 daily and weekly newspapers in and around the area of the Experiment. Approximately 1500 copies of the quarantine were printed and distributed to county agents and farmers throughout the area. Throughout the two years of the Experiment, five to seven district entomologist of the Division of Plant Industry living in and around the area covered by the Experiment devoted the necessary time contacting ginners and farmers to acquaint them with the provisions of the quarantine.

Conditions governing the movement of regulated articles and issuance of certificates and permits were written into the quarantine. Regulated articles included the boll weevil in any living stage of development, seed cotton, gin trash, mechanical cotton pickers and any other products, articles or means of conveyance of any character whatsoever, not covered by the quarantine when they presented a hazard of spread of the boll weevil. It also prohibited the growing of volunteer or ornamental cotton.

On February 28, 1972, the quarantine was amended to set an optimum planting date before which no cotton could be planted within the eradication and first buffer areas to allow trap crop rows of cotton treated with an in-furrow treatment of a systemic insecticide to be planted by operations personnel prior to farmer planted cotton. Public notice of this amended quarantine was printed in several daily papers having circulation within the experimental area and approximately 1500 copies of the amended quarantine were distributed to county agents, farmers and other interested parties throughout the area.

Three ornamental plantings of cotton were destroyed in the summer of 1971 and two in the summer of 1972. One farmer in the eradication area in late September and early October 1971, lost three heifers, each weighing about 400 pounds and approximately 20 chickens, which he associated with insecticides used in the program. He indicated he would not participate nor allow operations personnel on his property during the 1972 growing season. This made it necessary for the State Entomologist to write a letter to the aggrieved farmer explaining his rights and the injunctive measures which could be taken by the state to prohibit his interference with the program. The State Entomologist, accompanied by an entomologist of the Mississippi Cooperative Extension Service called on the aggrieved party on March 13, 1972, to discuss the matter with him and deliver the letter. After fully explaining the program, the farmer agreed to participate and continued to do so throughout the remainder of the Experiment.

Other than these rather minor regulatory problems, excellent cooperation was given by all concerned.

O.T. Guice, Jr.

O. T. Guice, Jr.
State Entomologist

September 6, 1973

Addendum C.

THE ROLE OF THE COOPERATIVE EXTENSION SERVICE IN THE BOLL WEEVIL ERADICATION EXPERIMENT

The Cooperative Extension Service was responsible for the organizational/educational portion of the Boll Weevil Eradication Experiment.

From the beginning of the project, Extension personnel motivated farmers to unify their efforts to control the boll weevil. Extension entomologists from the three states involved visited with county agents to explain the purpose and techniques of the experiment. They also explained what role the Cooperative Extension Service was to play in the overall effort. These local agents, in turn, presented the objectives and operational procedures to cotton producers and the general public.

Mississippi Cooperative Extension Service personnel organized monthly progress meetings at Prentiss, Mississippi (eradication headquarters). Representatives from the several federal and state organizations involved in the experiment used these meetings to discuss progress and problems.

Cooperation of the agencies involved was excellent; due partially, we feel, to these progress meetings. Extension personnel also established work unit supervisor and county agent training sessions to give them the opportunity to discuss eradication problems. These sessions were held bi-monthly or as needed during the cotton growing season.

MORE

Several methods were used to inform cotton producers of the experiment and how they would benefit from it. Countywide producer meetings, community meetings, individual contacts, radio, T.V., and newspapers were used to spread information concerning the experiment. Weekly weevil eradication newsletters, prepared by the Extension entomologist and mailed by the county agents, helped to keep cotton producers informed of current developments. Boll weevil infestation counts were obtained through the operations office each week and mailed to producers through the county agents.

As the experiment progressed, the Boll Weevil Eradication film was widely used in promoting and explaining the program. These educational channels continued to be used as needed to keep producers and the general public informed.

Extension personnel acted as a liaison between operations and cotton producers in problem solving. Guidelines were established to be used in reporting suspected damage from insecticide applications. Extension educational channels were also used to minimize the theft of boll weevil (Legget) traps soon after they were placed out at the start of the program.

A continuous flow of news and information about the experiment went out to producers and public alike. If there were problems, Extension personnel assisted in identifying and finding solutions to them. Significant progress and invaluable experience were obtained in dealing with cotton producers in the pilot experiment. It is felt that this knowledge will be of great value in future beltwide programs.

APPENDIX C

Statement by the Technical Guidance Committee for the Pilot Boll Weevil Eradication Experiment August 1973

The technical Guidance Committee for the Pilot Boll Weevil Eradication Experiment has maintained close contact with the progress and problems in the conduct of the experiment from the time of its initiation in August 1971 and its termination in August 1973. The purpose of the experiment was to determine if it is technically and operationally feasible to eliminate populations of the boll weevil by integrating several suppression techniques while concurrently making improvements in the application of available technology.

The experiment, centered in southern Mississippi and in adjacent areas in Alabama and Louisiana, is representative of the worst boll weevil conditions likely to be encountered in the boll weevil belt. The suppression methods involved the application of insecticides, the use of the boll weevil aggregating and sex pheromone (grandlure) in traps and trap crop planting, the release of sterile males, and the institution of certain cultural measures, including restricted planting dates, early stalk destruction, and the use of cotton growth inhibitors. Much new information was obtained on the biology, ecology, dynamics, and behavior of the boll weevil that is relevant to the development of suppression strategies. Based on the results and experiences gained in the conduct of the experiment, the Guidance Committee has reached the conclusion stated below and offers recommendations to appropriate agencies for additional research and development that is urgently needed to implement and to achieve maximum effectiveness and economy of operations in the event that a national program is undertaken to eliminate the boll weevil as an economic pest in the United States.

I. Conclusion

Based on the results and experiences gained in the Pilot Boll Weevil Eradication Experiment conducted in south Mississippi and adjacent areas in Alabama and Louisiana, and mindful that the experiment was conducted in an area representative of the most severe boll weevil conditions likely to be encountered in the boll weevil belt, the Technical Committee has reached the conclusion that it is technically and operationally feasible to eliminate the boll weevil as an economic pest in the United States by the use of techniques that are ecologically acceptable. The economic and environmental benefits of achieving this goal will far exceed the costs that will be involved. For such program to be successful, it must be carried out with thoroughness and precision. The participation of a number of agencies will be required. Complete cooperation and participation by all cotton growers in the boll weevil belt is essential.

II. Recommendations

In the conduct of the pilot experiment, it became apparent that improvements in technology and/or operational procedures for certain suppression components will be necessary to maximize efficiency and economy in the elimination of the boll weevil. Accordingly, the Committee recommends that while detailed plans and facilities for the initiation of a program are under development, research be continued and intensified immediately to further improve the technology and operations relating to the following:

1. Improve mass rearing procedures to assure the capability of producing adequate numbers of high quality boll weevils for sterilization and release.

2. Improve techniques of sterilization to assure the attainment of maximum and consistent high levels of sterilization with a minimum of detrimental effects on the vigor and mating competitiveness of the males.

3. Develop new methods of sterilizing both sexes of the boll weevil so as to obviate the cost of separating sexes and to reduce costs and logistic problems associated with the feeding of boll weevils for 6 days before they are released.

4. Continue investigations on grandlure to develop the most effective and least costly method of employing the attractant for: (a) suppression, (b) as a means of detection and population assessment, and (c) as a means of monitoring progress in population suppression.

In recommending the urgency of research on the items listed, the Committee does not wish to minimize the need for continuing investigations on other aspects of the boll weevil problem. It is important that ecological research be continued and intensified in various areas of the boll weevil belt, particularly to obtain information on the time of the season and the proportion of field populations that enter hibernation and to locate optimal hibernating sites. Such information is especially relevant to decisions on the degree of inseason control that should be attained by growers and when the reproduction-diapause suppression component should be initiated. Also, accurate information on the time and proportion of the boll weevils that emerge from hibernation is needed for various areas in order to establish appropriate planting dates and to determine when to apply the pheromone and sterile male release components for maximum effects.

Additional information in various areas on possible differences in the response of boll weevils to pheromones during the late season migration period, during spring emergence from hibernation, and while boll weevils are in cottonfields is also necessary to develop optimal strategies for suppression and detection of boll weevils by the use of the pheromone, grandlure.

APPENDIX D

THE PILOT BOLL WEEVIL ERADICATION EXPERIMENT

Report of the Entomological Society of America Review Committee

The historical background of the boll weevil as a cotton pest in the United States is readily available in a recent review by Cross (1973).[1] Cross also summarized, very briefly, plans for a pilot eradication experiment. More details of the eradication experiment plans are given in a U. S. Department of Agriculture circular (1971).[2] Persons interested in background information about the experiment should consult those sources. Additional detailed information may be obtained from various working documents developed during the course of planning the experiment, the more important of which are:

Selection of Locations for the Pilot Boll Weevil Eradication Experiments. A report of findings of a subcommittee appointed by the National Cotton Council's Special Study Committee on Boll Weevil Eradication to select representative areas suitable for pilot boll weevil eradication experiments. August 15, 1969.

USDA Environmental Statement, prepared in accordance with 100(2)(C) of P. L. 91–190. August 2, 1971.

Very briefly, the pilot eradication experiment consisted of a field trial designed to determine if various population suppression techniques, when used in concert, were adequate to eradicate a boll weevil population from a prescribed area. The area chosen for the experiment (Fig. 1) was selected because it was thought to represent the most difficult of the cotton producing areas in which to achieve eradication of a population.

It was clearly recognized in the beginning that the area selected did not represent the broad spectrum of cotton production areas of the United States, and was chosen more as an extreme than as a representative example. It was further recognized that in an actual eradication program different problems would arise in different regions, and that the techniques available and those used in the pilot trial might be either more or less effective in the chosen region than in many others.

The area was comprised of a core area of roughly 25 miles radius around Columbia, Mississippi, surrounded by three buffer zones in which population suppressive measures designed to minimize infiltration of the core area by weevils would be applied. In the first buffer zone, approximately 50 miles wide, it was intended that suppressive measures applied be essentially the same as in the core area, although monitoring of results was much less intensive. The outer 2 buffer zones received less intensive population suppressive actions. Operational headquarters for the experiment were established at Prentiss, Mississippi, in the northern part of the core area.

Some idea of the operational complexity of this eradication attempt will be evident from data on cotton plantings in the eradication zone and first buffer zone. In 1971, the first season of the experiment, the combined acreage in the eradication zone was 3222. In 1972 the cotton plantings in the eradication zone totaled 2906 acres, and by 1973 the plantings had been reduced to 1889 acres, distributed among 162 fields. This reduction in acreage was accomplished by purchasing and destroying many of the smaller plantings that had proven difficult and expensive to treat and monitor during the preceding seasons. In 1971 the first buffer zone contained 3605 acres of cotton; 3905 acres in 1972; and in 1973 this was increased to a total of 5605 acres distributed among 359 fields.

The initial intent was for the program to run for two complete years—July, 1971 through June, 1973. Because of budgetary delays, effective suppressive measures were not applied with any degree of consistency during the 1971 season, and the program was not fully operational until well into 1972. Operational aspects of the program were continued into July, 1973, and monitoring of results in the core and first buffer zones extended to late August, 1973.

Population suppression components used in the experiment were:

1. Late season insecticide treatments to all growing cotton from late summer to harvest to kill the maximum possible number of weevils before they migrated to hibernation sites.
2. Late season cultural practices; dessication or defoliation of cotton plants before harvest, and stalk destruction afterward, to eliminate late season development and reduce food and harborage for weevils surviving the pesticide treatments.
3. Spring time use of grandlure, an aggregating and sex pheromone, to attract and destroy weevils emerging from hibernation. Trap use was continued throughout the season, although effectiveness declined as farmer cotton reached the squaring stage.
4. Trap crops of cotton planted 2 weeks before general planting. These trap crops were planted near hibernation sites, usually around the margins of normal fields, and treated with systemic insecticides that kill weevils that feed on the plants.
5. Release of sexually sterile male weevils to overflood native wild weevil populations by a ratio of at least 50 to 1.
6. In-season insecticidal programs, and special insecticidal treatment of "hot spots" of weevil infestation that were discovered in the core and first buffer zones as a result of monitoring activities.
7. On occasion, small plantings were completely destroyed.

Results of the experiment, as it progressed, were monitored by three methods: (1) field inspections of insect populations by experienced scouts; (2) pheromone baited traps; and (3) a mechanical insect population sampler ("bug catcher") used primarily on trap crop plantings in the core area. Overwintering populations of weevils were also sampled by trash collections from favorable hibernation sites. Techniques followed in all these population sampling methods were standardized as much as possible to permit comparison of data from different areas. As with application of suppressive measures, the monitoring plan provided for intensification of sampling effort in and around detected "hot-spots" of weevil infestation. Details of the monitoring program are or will be available in published reports dealing with various aspects of the experiment.

In addition to critical monitoring of weevil populations, the experiment included careful monitoring of the effects of the eradication effort on non-target organisms, primarily honey bees and wildlife species that were known or thought possibly to be endangered by insecticide applications.

Throughout the experiment there was close coordination between the personnel responsible for operational aspects of the experiment and the research personnel of the several State and Federal laboratories engaged in research on cotton insect problems. Coordination was ac-

---

[1] Cross, W. H. 1973. Biology, control, and eradication of the boll weevil. Ann. Rev. Ent. 18, p. 17-46.

[2] U. S. Department of Agriculture. 1971. The pilot boll weevil eradication experiment. Un-numbered circular prepared by Plant Protection and Quarantine Programs, Animal and Plant Health Service, and Entomology Research Division, Agricultural Research Service, U.S.D.A.

FIG. 1. Location of the Pilot Boll Weevil Eradication Experiment.

complished through periodic meetings of research and operational personnel with the Technical Guidance Committee. Periodic progress reports were prepared and disseminated to all concerned personnel. This coordination permitted needed adjustments in the operational phases as technical problems surfaced, as well as critical appraisals of controversial issues. Examples of problems were: Design and fabrication of pheromone traps, development of a long-lasting pheromone wick for traps, trap placement, weevil migration, sampling precedures, mass production of weevils, and sterilization dosages for mass-produced weevils designed for field release.

In February, 1973 the joint chairmen of the Technical Guidance Committee, J. R. Brazzel and E. F. Knipling, invited the President of the Entomological Society of America to appoint a special committee "to assess the progress of the (pilot boll weevil eradication) experiment and to offer its appraisal and recommendations." Accordingly, President Gordon E. Guyer appointed a committee to "evaluate the technical and operational feasibility of . . . the program." This Committee (composition indicated at the end of this report) met in Mississippi on three occasions, April 5–6, June 26–27, and August 30, 1973, with members of the Technical Guidance Committee and research and operational personnel concerned with the experiment. These meetings enabled the Committee members to gain first-hand information and impressions of the background and rationale of the experiment, of the problems being encountered, and the progress in boll weevil population reduction, without which an appraisal of success or failure could scarcely have been made. We are deeply impressed with the vast amount of information about the boll weevil that was brought to bear upon the eradication attempt, and the organization and execution of the logistical aspects of the experiment. The following parts of this report are concerned primarily with the Committee's evaluations and conclusions regarding the experiment. In arriving at its conclusions, the Committee interprets "eradication," in the sense of this experiment, to mean reduction of a specified population (in this case boll weevils in the core area) to zero. The Committee is divided as to whether or not a distinction should be made between "accomplishing eradication" and "demonstrating feasibility of eradication."

Data available at the termination of the experiment indicate that eradication was not accomplished in the core area. However, the program did demonstrate that populations of weevils can be reduced to extremely low levels through a regional suppressive program. Populations were so low that currently available sampling techniques could not detect them in most of the core area. The Committee is divided as to whether or not technical feasibility of eradication of boll weevil populations has

been demonstrated, but unanimously expressed reservations concerning any massive eradication undertaking without further research to refine suppressive techniques. We are also cognizant of the very complex operational difficulties that must be overcome if and when a more extensive boll weevil eradication effort is undertaken.

The reasons for the reservations we have about the success or significance of the eradication experiment are summarized in the following discussion of our appraisal and conclusions.

Although important technical and operational improvements were made and incorporated into the experiment as it progressed, much additional research in certain areas is essential to pursue the original program objectives. We believe the following to be the more significant limiting factors in the experiment, and they need to be researched prior to planning and implementing any future population suppression programs:

1. **Improvements in the mass production procedures.** Contamination of weevil stock with disease organisms, and other technical and operational problems prevented adequate production of high quality weevils needed for the sterile insect release program.
2. **Improved sterilization procedures.** If possible, the sterilization method should be effective for both sexes, in order to circumvent the costly step of sexing weevils prior to release, and to avoid the accidental release of fertile or only partially sterile females.
3. **Improved surveillance techniques.** Although pheromone baited traps, and particularly the model developed late in the experiment, give promise of being highly effective for population surveillance, continued research on the pheromone "grandlure" is strongly indicated. Further emphasis on grandlure as a population regulation tool is indicated. The mechanical population sampler is also a useful monitoring tool. But reliable data to indicate the population level that can be detected by these methods is lacking and therefore the only alternative appears to be the continuation of the monitoring program, as well as suppressive measures, over a considerable period of time to assure that eradication has indeed been accomplished.
4. **Determine the relative value of suppressive components.** Some research should be dedicated to an attempt to quantify the relative value of each component in the series of suppression techniques in different regions. Following research designed to further improve suppressive techniques, it may be possible to simplify the overall effort by restructuring the program and perhaps even to delete one or more components. For example, if improvements in certain techniques (e. g. pheromones) prove sufficient to accomplish desired goals, the expensive, problem-ridden sterile insect release system may be unnecessary.

The core area was smaller than desirable and the experiment was terminated considerably short of the optimal time period. Problems associated with the small size of the core area were accentuated by the fact that proper and complete suppression methods could not be applied throughout the first buffer zone. Had the core area been larger, and adequately protected by a thorough suppression program in the first buffer zone, better estimates of the migration component would have been obtained.

The effectiveness of the population suppression measures employed in this experiment become obvious from data on native weevils captured during the 1972 and 1973 seasons. Released sterile weevils, distinguished by a genetic marker "mahogany," that were captured are not included in the following data.

In 1972 there were 156,580 weevils captured in the eradication zone; in 1973 the total was 1436. Of these, 173 came from the immediate vicinity of field No. 120, a small planting that was not discovered—and consequently not treated—until September 20, 1972, by which time a considerable number of diapausing weevils had presumably moved into hibernation. Further, of the total 1973 captures in the eradication zone, 960 came from Unit 4 which contained field No. 120. The number of weevils captured per planted acre in 1972 was 54; in 1973 the figure was 0.79.

In the first buffer zone the total weevil catch during 1972 was 132,350, an average of 32.3 per planted acre. In 1973 the total caught was 3940; the average per planted acre 0.82.

Population monitoring data available on August 30, 1973, indicate that native weevils had been reduced to an extremely low level throughout most of the core area. No native adult weevils were found in any of the 236 fields of the core area during the final week of the experiment. However, oviposition punctures were found in cotton squares in 6 of the fields that week. The fields in question are near a part of the first buffer zone where persistent infestations were known to exist throughout the period of the experiment, and although available information and the opinions of the survey personnel suggest that the oviposition punctures found in the core area resulted from migration of native weevils into the core area, no unequivocable evidence exists to support that contention.

Large scale field trials of any kind usually bring to light a multitude of unanticipated operational problems, and the pilot boll weevil eradication experiment was no exception. The periodic progress reports are replete with accounts of operational problems, small and large, that had to be solved. These involved such diverse matters as design and development of a trash sampling machine, design and production of practical boll weevil pheromone traps, swath width for aerial treatment of cotton with insecticides, coordination of agronomic practices, standardization of field inspection procedures, and methods of sterile weevil release. During the 1971 season it became evident that growers in the first buffer zone, who were initially expected to conduct the in-season insecticide application program, did not have the proper equipment to do the job. Consequently, in 1972 and 1973 it became necessary for the program's operational personnel to take over that task, thus further taxing the already strained financial support of the program. One of the most disturbing developments, indicative of the kind of operational problem that could effectively negate a large-scale eradication effort, was the failure to detect one cotton field in the core zone until near the end of the second growing season.

In the opinion of this Committee, the major difficulties that will attend any massive effort against the boll weevil are likely to be less those of a technical nature than of the operational aspects—particularly "people problems" involved in implementing and carrying out the strategies and tactics chosen for suppression of boll weevil populations. Further, any large-scale pest suppression or eradication undertaking inevitably brings about an interplay of very diverse social, political and economic interests, and reactions to a proposed boll weevil eradication effort will not be limited to the cotton producing areas. The cooperation of cotton growers and participation of the appropriate government agencies in such a program will not alone be sufficient, even assuming adequate financing which is essential for a venture of this kind.

This Committee does not presume to know whether or not a Belt-Wide boll weevil eradication effort should be undertaken. However, we have reservations until such time as currently available suppressive techniques are improved and collectively tested in different geographical

and/or ecological areas. We are convinced that the information and experience gained from this experiment have provided invaluable techniques to growers throughout the Cotton Belt for managing populations of this most pernicious pest. We believe the decision regarding attempted eradication should and will be a socio-political decision. Accordingly, we recommend that a detailed summary of this program be published and that all concerned persons, and especially all entomologists, inform themselves as to the long range environmental and economic benefits that would result from a successful eradication program and weigh those against the costs involved. If pest management is to play its proper role in resource management, decisions as to programs to be undertaken must be made objectively and realistically, and those programs implemented must be prosecuted vigorously and decisively.

The members of this Committee wish to express their appreciation to the personnel of the boll weevil eradication experiment for the gracious hospitality and generous cooperation extended us during the course of this review. Copies of progress and research reports were promptly supplied, and information about all aspects of the program freely given. We also express our appreciation to the Entomological Society of America for having had the opportunity to participate, in a small way, in this interesting and important program.

H. C. Chiang
E. H. Glass
D. L. Haynes
Paul Oman
H. T. Reynolds
W. G. Eden, *Chairman*

Criteria for Selection of a Site for a 3-year Eradication Trial for the Boll Weevil and the Status of Each

1. Grower and Technical Support

Texas and Oklahoma--High level of support evident among growers, cotton industry, and State research, extension, and regulatory officials.

Virginia, North Carolina, and South Carolina--High level of support evident among growers, cotton industry, and State research, extension and regulatory officials.

2. Grower Organization

Texas and Oklahoma--Generally growers are better organized into grower groups.

Virginia, North Carolina, and South Carolina--Some grower organization, but not as strong as in the southwest.

3. Prior Experience in Operations

Texas and Oklahoma--Program personnel have 10 years of experience in the execution of a diapause boll weevil control program in the area.

Virginia, North Carolina, and South Carolina--No previous organized program experience against the boll weevil. Because of this and the severity of the weevil, it is expected that the program would have to start on a relatively small acreage so that training of personnel could be intensified.

4. Execution of Program Operations

Texas and Oklahoma--Operations would be easier to execute because of the large fields, open terrain, and a minimum of obstacles for aerial treatment.

Virginia, North Carolina, and South Carolina--Operations will be more difficult and require more personnel per unit because of small fields and obstacles to aerial treatment.

5. Logistics of Program Operation

Texas and Oklahoma--The initiation and execution of a program on over 2 million acres could present problems because of the amount of equipment and number of personnel required.

Virginia, North Carolina, and South Carolina--Overall logistics would be less because less acreage involved.

6. Severity of the Boll Weevil Problem

Texas and Oklahoma--Weevil problems are sporadic and are less secure than in the southeast. This would allow training of personnel to be accomplished easier while advancing the program through the area.

Virginia, North Carolina, and South Carolina--Weevil problems severe, thus training of personnel would be more crucial.

7. Size of Area and Degree of Isolation

Texas and Oklahoma--It would require inclusion of approximately 2.1 million acres to do the trial and move approximately 250 miles across the infested area.

Virginia, North Carolina, and South Carolina--It would require inclusion of approximately 1/2 million acres to move the program approximately 350 miles across the infested area.

8. Degree of Hazard of Reinfestation from Established Infestations

Texas and Oklahoma--A holding line would be required beginning the third year between the Texas and Mexican border and the program area to prevent reinfestation from the south.

Virginia, North Carolina, and South Carolina--No holding line to prevent reinfestation from behind the program would be required.

9. Cost for First Year (Government/Grower in Millions)

Texas and Oklahoma--First year cost of the program would be approximately 32 million dollars for the Government and 4 million dollars for the growers.

Virginia, North Carolina, and South Carolina--First year cost would be 5 million dollars for the Government and 5 million dollars for the growers.

10. Cost for Total 3-year Program

Texas and Oklahoma--The total cost for the 3-year program would be approximately 100 million dollars on 2.1 million acres.

Virginia, North Carolina, and South Carolina--The total cost would be 70 million dollars on 1/2 million acres.

11. Expected General Public Support for Economic Benefits

Texas and Oklahoma--This is predominantly an agricultural area with more support of the general public for agricultural problems.

Virginia, North Carolina, and South Carolina--Less intensive agricultural area with a possibility of more nonfarm critics of the program.

12. Expected General Public Support for Environmental Benefits

Texas and Oklahoma--Environmental support would be less than in southeast since only two to three applications of pesticide/year are applied.

Virginia, North Carolina, and South Carolina--Fifteen to 20 applications per year are being applied.

13. Economic Benefits to Producers

Texas and Oklahoma--Immediate benefits to the growers on a per acre basis would be small in comparison to the southeast since the weevil is not a consistent and severe problem in much of the area.

Virginia, North Carolina, and South Carolina--Benefits to the growers would accrue immediately since the boll weevil is a consistent and severe problem.

14. General Acceptance of Success in a Trial as Applicable to the Entire Infested Area

Texas and Oklahoma--Since this area has sporadic boll weevil problems, results obtained would be less creditable.

Virginia, North Carolina, and South Carolina--Because of the severity of the boll weevil problem, results obtained would be acceptable by program critics as proof of the proof of the program.

15. Benefits of Experience to Effect Pest Management in Cotton in Case the Trial Eradication Program was not Completely Successful

Texas and Oklahoma--Due to the diversity in the cotton growing areas, pest management would be complex.

Virginia, North Carolina, and South Carolina--Would be easier to implement pest management since the insect problems in this area have more common characteristics.

APPENDIX F

Implementation Schedule - 1976

Sequence of scheduled events and responsible parties for action steps in preparation and execution of the trial eradication program.

Pretrial Practices

1. In-season Control (Grower)

2. Diapause Control (Grower)

3. Information and Education (CES)

4. Reasonable Goals (ARS)

Description of Practice:

1. Follow State recommendations for control of the boll weevil to realize lower populations during the diapause program in the fall.

2. Diapause--Grower will be urged to execute a diapause control program over the entire area prior to initiation of the eradication program the following year. This activity will be purely voluntary on the part of the grower. However, execution by 100 percent of the producers will substantially enhance the potential for successful execution of the eradication program on the schedule given above.

3. Information and Education--Will conduct an intensive information and education program to achieve maximum effectiveness in the in-season and diapause control activities by the growers. This will include the basic essentials of the eradication technology, sequence of execution, the producers' role in the program, and potential benefits.

4. By December 1976 a standard operation procedure will be developed for the mass rearing operation. This will include the basic mechanization of the process and be ready to initiate production buildup in early 1977.

1st Year of Program (1977)

1. Cooperate with Program Personnel (Grower)
2. Map (APHIS & ASCS)
3. Traps (APHIS)
4. Survey (APHIS)
5. In-season Control (APHIS)
6. Diapause Control (APHIS)
7. Defoliation/Dessication (APHIS)
8. Regulatory (APHIS)
9. Research Goals (ARS)

1. Cooperate with program personnel by location of all cotton plantings, allow personnel access to all fields, plant cotton in most accessible fields from standpoint of chemical treatment if possible, and report any unusual pest situations that are observed.

2. Map--With the assistance of the growers and ASCS, develop maps showing every field of cotton in the zone.

3. Traps--Pheromone-baited traps will be located around every cotton-field in the zone at the rate of 1/2 acre during the growing and harvest season. Traps will be maintained at a lesser level for survey purposes during the fall and winter.

4. Conduct a survey--Initiate visual surveys with the emergence of cotton to determine population levels of the boll weevils and other cotton pests. These data will be used to time the necessary in-season control treatments.

5. In-season cotton pest control during the growing season will be done by APHIS. Treatments will be made in compliance with the recommendations of the appropriate States.

6. Diapause Control--Diapause control treatments will be initiated on the appropriate schedule following termination of the cotton crop. These will be continued until stalk destruction, either by mechanical means or by frost.

7. Defoliation/Dessication--All cotton will be defoliated or dessicated as appropriate in order to hasten harvest operations and to reduce the boll weevil food and breeding sites.

8. Regulatory--The necessary regulatory actions governing movement of seed cotton and equipment which offer a hazard of transport of boll weevil into the eradication area. Authority for access and entry to execute these program components must be assured for 100 percent of the cotton acreage in the eradication zone.

9. By December 1977 have completed the following:

(a) Identified most practical trap type for use in saturation trapping program in 1978-79.

(b) Identified the best method for sterilization of boll weevils for release in 1978.

(c) Have completed the necessary research on efficacy of Dimilin and determined if this suppression measure has a role in the eradication trial.

2nd Year (1978)

1. Cooperate with Program Personnel (Grower)
2. Control Other Pests (Grower)
3. Defoliation (Grower)
4. Map (APHIS & ASCS)
5. Traps (APHIS)
6. Trap Crops - Aggregation Control, (APHIS)
7. Survey (APHIS)
8. Pinhead Square Treatment (APHIS)
9. Sterile Insects (APHIS)
10. In-season (if needed) (APHIS)
11. Diapause (if needed) (APHIS)
12. Stalk Destruction (Grower)
13. Regulatory (SDA & APHIS)

1. Cooperation.

2. Control of other pests--In the second year of the program it is expected that boll weevil populations will be so low that only isolated spot treatments with chemicals will be required. The growers will be responsible for control of all other pests by a management program unless program treatments create a secondary pest problem. In this event, control will be a program responsibility.

3. Defoliation--Defoliation will be a farmer responsibility during the second year of the program because it is not anticipated that a fall diapause program will be needed.

4. Map--Same as #2 in 1st year.

5. Trap--Same as #3 in 1st year.

6. Trap Crops - Aggregation Control--The trial area is too far north with a short growing season to permit planting of specific trap crop plots. In this area the periphery of fields adjacent to boll weevil

hibernation quarters will be baited with pheromone to aggregate weevils in this area. These areas will be treated regularly with pesticide by ground application equipment in the early season to destroy these boll weevils.

7. Survey--Visual surveys will begin with the emergence of cotton and continue throughout the season. These surveys will be more in the form of a detection survey to determine the degree to which program activities in 1975 have eliminated weevil populations and identify areas which need special attention.

8. Pinhead Square Treatment--A chemical treatment will be made to fields just before squares are large enough for oviposition if surveys indicate such a treatment is needed.

9. Sterile Insects--Sterile insects will be distributed at the rate of 50-100/acre per peck over the entire cotton acreage beginning in June and continuing until stalk destruction in the fall.

10. In-season (if needed)--Where surveys reveal incipient weevil infestations, appropriate insecticidal treatments will be made.

11. Diapause (if needed)--In the event populations develop in localized areas, a diapause program will be executed to insure maximum suppression of overwintering boll weevils.

12. Stalk Destruction (where needed)--Same as #3 in 1st year.

13. Regulatory--Same as #9 in 1st year.

3rd Year (1979)

1. Cooperate with Program Personnel (Grower)

2. Other Pests (Grower)

3. Defoliation (Grower)

4. Map (APHIS & ASCS)

5. Traps (APHIS)

6. Trap Crops (where needed) (APHIS)

7. Survey (APHIS)

8. Sterile Insects (where needed) (APHIS)

9. In-season (if needed) (APHIS)

10. Regulatory (SDA & APHIS)

1. Same as #1 in 2nd year.

2. Other Pests--Same as #2 in 2nd year.

3. Defoliation--Same as #3 in 2nd year.

4. Map--Same as #4 in 2nd year.

5. Traps--Same as #5 in 2nd year.

6. Same as #6 in 2nd year if surveys revealed incipient infestations in the 2nd year.

7. Survey--Visual surveys will be continued throughout the area as a means of detecting any weevils which have survived the program up to this point.

8. Sterile insects will not be used in the evaluation area during the third year of the trial since their presence would complicate evaluation. However, they would be used outside this area to create a barrier to migrating boll weevils.

9. In-season (if needed)--Insecticidal treatments will be made to any fields in which incipient infestations of boll weevil are found during the 2nd year.

10. Regulatory--The same as #13 in 2nd year.

Followup (1980)

1. Other Pests (Grower)

2. Regulatory (SDA & APHIS)

3. Surveillance (SDA & APHIS)

1. Other Pests--The same as #2 in 3rd year.

2. Regulatory--The same as #10 in 3rd year.

3. Surveillance--The regulatory agencies will assume the responsibility for routine surveillance of the areas cleared of the boll weevil by the program. This will be a continuing activity.

APPENDIX G

National Cotton Council
Special Study Committee on Boll Weevil Eradication
1968

Producer Members

Mr. Robert R. Coker (Chairman)
Post Office Box 340
Hartsville, South Carolina 29550

Mr. Marshall Grant
Route 1
Garysburg, North Carolina 27831

Mr. P. R. Smith
Post Office Box 593
Winder, Georgia 30680

Mr. Albert McDonald
6800 Old Madison Pike
Huntsville, Alabama 35806

Mr. H. T. Greet
Anguilla, Mississippi 38721

Mr. Vernon Scott
Post Office Box 98
Tillar, Arkansas 71670

Mr. C. J. Grayson
Fort Necessity, Louisiana 71243

Mr. Don Anderson
Post Office Box 1474
Lubbock, Texas 79408

At-Large Members

Mr. Eugene Butler
The Progressive Farmer
3612 Noble Avenue
Dallas, Texas 75204

Dr. E. F. Knipling
Agricultural Research Service
U. S. Department of Agriculture
Beltsville, Maryland 20705

Dr. J. R. Brazzel
Animal and Plant Health Inspection Service
U. S. Department of Agriculture
Federal Center Building #1
Hyattsville, Maryland 20782

Dr. T. B. Davich
USDA Boll Weevil Research Laboratory
Post Office Box 5367
Mississippi State, Mississippi 39762

Mr. J. Ritchie Smith (Secretary)
National Cotton Council
Post Office Box 12285
Memphis, Tennessee 38112

Dr. P. L. Adkisson
Texas A&M University
College Station, Texas 77843

Dr. David F. Young, Jr.
Mississippi State University
Post Office Box 5426
Mississippi State, Mississippi 39762

Dr. C. R. Jordan
The University of Georgia
Athens, Georgia 30601

Dr. George Slater
Cotton Incorporated
4505 Creedmoor Road
Raleigh, North Carolina 27612

APPENDIX H

Technical Guidance Committee
Pilot Boll Weevil Eradication Experiment
July 1971

Dr. P. L. Adkisson
Department of Entomology
Texas A&M University
College Station, Texas 77843

Dr. F. S. Arant
Department of Zoology and Entomology
Auburn University
Auburn, Alabama 36830

Mr. Richard Carlton
State Department of Agriculture
Box 44153, Capitol Station
Baton Rouge, Louisiana 70804

Dr. T. B. Davich
Boll Weevil Research Laboratory
ARS, U.S. Department of Agriculture
P. O. Box 5367
Mississippi State, Mississippi 39762

Mr. C. C. Fancher
Mississippi Department of
Agriculture & Commerce
P. O. Box 1609
Jackson, Mississippi 39205

Mr. O. T. Guice
Mississippi State Plant Board
Mississippi State University
Mississippi State, Mississippi 39762

Dr. F. G. Maxwell
Department of Entomology
Mississippi State University
P. O. Drawer EM
Mississippi State, Mississippi 39762

Dr. R. C. Riley
Cooperative State Research Service
U. S. Department of Agriculture
Washington, D.C. 20250

Mr. W. F. Helms
PPD Station Headquarters
P. O. Box 2169
Jackson, Mississippi 39205

Dr. J. S. Roussel
Louisiana State Experiment Station
Baton Rouge, Louisiana 70803

Dr. W. A. Ruffin
Department of Agriculture & Industries
P. O. Box 220
Montgomery, Alabama 36104

Dr. D. R. Shepherd (retired)
Animal and Plant Health Inspection
Service
U. S. Department of Agriculture
Federal Center Building
Hyattsville, Maryland 20782

Dr. George Slater
Cotton Incorporated
4505 Creedmoor Road
Raleigh, North Carolina 27612

Mr. Ritchie Smith
National Cotton Council of America
P. O. Box 12285
Memphis, Tennessee 38112

Dr. D. F. Young
Mississippi State University
P. O. Box 5426
Mississippi State, Mississippi 39762

Mr. C. R. Parencia (Secretary)
ARS, U. S. Department of Agriculture
Agricultural Research Center, West
Beltsville, Maryland 20705

Dr. J. R. Brazzel (Co-Chairman)
APHIS, U. S. Department of Agriculture
Federal Center Building
Hyattsville, Maryland 20782

Dr. E. F. Knipling (Co-Chairman)
ARS, U. S. Department of Agriculture
Room 205, National Agricultural Library
Beltsville, Maryland 20705

APPENDIX I

Technical Subcommittee
To Develop
Overall Plan for Boll Weevil Eradication
1973

Dr. E. F. Knipling (Chairman)
Science Advisor to Administrator
ARS-USDA
Room 205, National Agriculture Library
Beltsville, Maryland 20705

Dr. J. R. Brazzel (Vice Chairman)
Chief Staff Officer
Methods Development, Plant Protection Division
Animal and Plant Health Inspection Service - USDA
Federal Center Building
Hyattsville, Maryland 20782

Dr. Perry Lee Adkisson, Head
Department of Entomology
Texas A&M University
College Station, Texas 77843

Dr. C. R. Jordan, Chairman
Division of Entomology
The University of Georgia
Hoke Smith Annex
Athens, Georgia 30601

Dr. David F. Young, Jr.
Leader, Extension Entomology
Mississippi State University
Post Office Box 5426
Mississippi State, Mississippi 39762

Mr. H. L. Bruer, Director
Division of Plant Industry
State Department of Agriculture
P. O. Box 40627
Nashville, Tennessee 37204

Dr. George Slater
Director of Agricultural Research
Cotton Incorporated
4505 Creedmoor Road
Raleigh, North Carolina 27612

Dr. James M. Brown
Manager, Production Technology
National Cotton Council of America
P. O. Box 12285
Memphis, Tennessee 38112

Dr. H. M. Taft
USDA Entomologist
Pee Dee Experiment Station
Florence, South Carolina 29501

Dr. C. R. Parencia (Secretary)
Entomologist-National Program Staff
ARS-USDA
North Building
Plant Industry Station
Beltsville, Maryland 20705

APPENDIX J

Mailing List of Recipients of Draft Environmental Impact Statement and Comments Received

1. Commissioners of Agriculture

(a) Honorable S. Mason Carbaugh, Commissioner
Virginia Department of Agriculture and Commerce
P.O. Box 1163
Richmond, VA 23209

(b) Honorable James A. Graham, Commissioner
North Carolina Department of Agriculture
Box 27647
Raleigh, NC 27611

(c) Honorable William L. Harrelson, Commissioner
South Carolina Department of Agriculture
P.O. Box 11280
Columbia, SC 29211

(d) Honorable Thomas T. Irvin, Commissioner
Georgia Department of Agriculture
Agriculture Building, Capitol Square
Atlanta, GA 30334

(e) Honorable Doyle Conner, Commissioner
Florida Department of Agriculture and Consumer Services
The Capitol
Tallahassee, FL 32304

(f) Honorable M. D. Gilmer, Commissioner
Alabama Department of Agriculture and Industries
P.O. Box 3336
1445 Federal Drive
Montgomery, AL 36109

(g) Honorable Guilford F. Thornton, Commissioner
Tennessee Department of Agriculture
Box 40627, Melrose Station
Nashville, TN 37204

(h) Honorable Jim Buck Ross, Commissioner
Mississippi Department of Agriculture and Commerce
P.O. Box 1609
Jackson, MS 39205

(i) Honorable Wallace Martin
Chairman
Arkansas State Plant Board
P.O. Box 1069
Little Rock, AR 72203

(j) Honorable Dave L. Pearce
Commissioner
Louisiana Department of Agriculture
P.O. Box 44302, Capitol Station
Baton Rouge, LA 70804

(k) Honorable James B. Boillot
Commissioner
Missouri Department of Agriculture
Jefferson State Office Building
Jefferson City, MO 65101

(l) Honorable Billy R. Gowdy
President
Oklahoma State Board of Agriculture
122 State Capitol Building
Oklahoma Ciy, OK 73105

(m) Honorable John C. White
Commissioner
Texas Department of Agriculture
Drawer 12847, Capitol Station
Austin, TX 78711

Head, Departments of Entomology

(a) Dr. J. M. Grayson
Head, Department of Entomology
University of Virginia
Blacksburg, VA 24061

(b) Dr. K. L. Knight
Head, Department of Entomology
North Carolina State University
Raleigh, NC 27607

(c) Dr. S. B. Hays
Head, Department of Entomology
Clemson University
Clemson, SC 29631

(d) Dr. C. R. Jordon
Department of Entomology
University of Georgia
Athens, GA 30601

(e) Dr. W. G. Eden
Head, Department of Entomology
and Nematology
University of Florida
Gainesville, FL 32601

(f) Dr. F. S. Arent
Head, Department of Zoology and Entomology
Auburn University
Auburn, AL 36830

(g) Dr. C. J. Southards
Head, Department of Agricultural Biology
University of Tennessee
Knoxville, TN 37901

(h) Dr. F. G. Maxwell
Head, Entomology Department
Mississippi State University
State College, MS 39762

(i) Dr. F. D. Miner
Head, Department of Entomology
University of Arkansas
Fayetteville, AR 72701

(j) Dr. L. D. Newsom
Head, Department of Entomology
Louisiana State Univeristy
Baton Rouge, LA 70802

(k) Dr. M. L. Fairchild
Chairman, Department of Entomology
University of Missouri
Columbia, MO 65201

(l) Dr. D. C. Peters
Head, Department of Entomology
Oklahoma State University
Stillwater, OK 74074

(m) Dr. P. L. Adkisson
Head, Department of Entomology
Texas A&M University
College Station, TX 77843

3. Director, Extension Services

   (a) Dr. W. E. Skelton
   Director, Cooperative Extension Service
   Virginia State University
   Blacksburg, VA 24061

   (b) Dr. George Hyatt, Jr.
   Director, Cooperative Extension Service
   P.O. Box 5157
   Raleigh, NC 27607

   (c) Dr. Wayne O'Dell
   Director, Cooperative Extension Service
   Clemson University
   Clemson, SC 29631

   (d) Dr. Charles P. Ellington
   Director, Cooperative Extension Service
   University of Georgia
   Athens, GA 30601

   (e) Dr. J. N. Busby
   Dean for Extension
   University of Florida
   Gainesville, FL 32601

   (f) Mr. Ralph R. Jones, Director
   Cooperative Extension Service
   Auburn University
   Auburn, AL 36830

   (g) Dr. William D. Bishop
   Dean, Agricultural Extension Service
   University of Tennessee
   Knoxville, TN 37901

   (h) Dr. William M. Bost
   Director, Agricultural Extension Service
   Mississippi State University
   Mississippi State, MS 39762

   (i) Mr. C. A. Vines, Director
   Cooperative Extension Service
   P.O. Box 391
   Little Rock, AR 72203

(j) Mr. John A. Cox
Director, Cooperative Extension Service
Louisiana State University
Baton Rouge, LA 70803

(k) Dr. Carl N. Scheneman
Vice President for Extension
Univeristy of Missouri
Columbia, MO 65201

(l) Dr. J. C. Evans
Vice President for Extension
Oklahoma State University
Stillwater, OK 74074

(m) Dr. John E. Hutchison
Director, Agricultural Extension Service
Texas A&M University
College, Station, TX 77843

4. Director, Experiment Stations

(a) Dr. C. T. Wilson
Director, Agricultural Experiment Station
University of Virginia
Blacksburg, VA 24061

(b) Mr. J. C. Williamson
Director of Research
North Carolina State University
Raleigh, NC 27607

(c) Dr. O. B. Garrison
Director, Agricultural Experiment Station
Clemson University
Clemson, SC 29631

(d) Dr. W. P. Flatt
Director, Agricultural Experiment Station
University of Georgia
Athens, GA 30601

(e) Dr. J. W. Sites
Dean of Research
Agricultural Experiment Stations
University of Florida
Gainesville, FL 32601

(f) Dr. E. V. Smith
Director, Agricultural Experiment
Station
Auburn University
Auburn, AL 36830

(g) Dr. J. A. Ewing
Dean, Agricultural Experiment Station
University of Tennessee
Knoxville, TN 37901

(h) Dr. J. H. Anderson
Director, Agricultural Experiment Station
Mississippi State University
State College, MS 39762

(i) Dr. E. M. Cralley
Director, Agricultural Experiment
Station
University of Arkansas
Fayetteville, AR 72701

(j) Dr. Doyle Chambers
Director, Agricultural Experiment Station
Louisiana State University
Baton Rouge, LA 70803

(k) Dr. E. R. Kiehl
Director, Agricultural Experiment
Station
University of Missouri
Columbia, MO 65201

(l) Dr. J. A. Whatley
Director, Agricultural Experiment Station
Oklahoma State University
Stillwater, OK 74074

(m) Dr. J. E. Miller
Director, Agricultural Experiment Station
Texas A&M University
College Station, TX 77843

5. U.S. Government Agencies

(a) Mr. T. W. Edminster
Administrator
Agricultural Research Service
Room 302-A, USDA
Washington, DC 20250

(b) Dr. R. L. Lovvorn
Administrator
Cooperative State Research Service
Room 313-A
U.S. Department of Agriculture
Washington, DC 20250

(c) Mr. Edwin L. Kirby
Administrator
Extension Service
U.S. Department of Agriculture
Room 5039-S
Washington, DC 20250

(d) Dr. Quentin M. West
Administrator
Economic Research Service
Room 448B-GHI, USDA
Washington, DC 20250

(e) Mr. Kenneth E. Frick
Administrator
Agricultural Stabilization and
Conservation Service
Room 206-W
U.S. Department of Agriculture
Washington, DC 20250

(f) Mr. Kenneth E. Grant
Administrator
Soil Conservation Service
Room 5105A-S
U.S. Department of Agriculture
Washington, DC 20250

(g) Mr. John R. McGuire
Chief, Forest Service
Room 3008-S
U.S. Department of Agriculture
Washington, DC 20250

(h) Dr. John Fedkiw
Deputy Director
Office of Planning and Evaluation
Room 115-A
U.S. Department of Agriculture
Washington, DC 20250

(i) Mr. Leo R. Gray
Director of Program Planning and
Evaluation, APHIS
Room 3165-S
U.S. Department of Agriculture
Washington, DC 20250

(j) Dr. J. M. Hejl
Deputy Administrator
Veterinary Service, APHIS
Room 312-E
U.S. Department of Agriculture
Washington, DC 20250

(k) Dr. F. J. Fullerton
Deputy Administrator
Meat and Poultry Inspection Program, APHIS
Room 329-E
U.S. Department of Agriculture
Washington, DC 20250

(l) Mr. Harold M. Carter, Director
Regulatory Division
Office of the General Counsel
Room 1207-S
U.S. Department of Agriculture
Washington, DC 20250

(m) Mr. Russell Train, Administrator
Environmental Protection Agency
Room W 1200
401 M Street, SW.
Washington, DC 20460

(n) Mr. Robert W. Norton, Director
Information Division, APHIS
Room 1143-S
U.S. Department of Agriculture
Washington, DC 20250

(o) Dr. Carl Leopold
National Science Foundation
1800 G Street, NW., Room 428
Washington, DC 20550

(p) Dr. F. A. Leone
U.S. Atomic Energy Commission
BDER, Room E 201
Washington, DC 20850

(q) Mr. Lynn Maish
OPE-USDA
Room 117-A
Washington, DC 20250

6. Grower Groups

(a) Mr. Hugh M. Arant, President
Mississippi Farm Bureau
P.O. Box 1972
Jackson, MS 39205

(b) Mr. Robert A. Carson
Co-chairman, Boll Weevil Action Committee
P.O. Box 5446
Mississippi State, MS 39762

(c) Mr. Robert Coker, President
Coker's Pedigreed Seed Company
P.O. Box 340
Hartsville, SC 29550

(d) Mr. Ed Dean
Plains Cotton Growers
1720 Avenue M
Lubbock, TX 79401

(e) Mr. Dalton Gandy
National Cottonseed Products Association
2400 Poplar Avenue
Memphis, TN 38112

(f) Mr. Marshall Grant
North Carolina Boll Weevil Action Committee
Route 1
Garysburg, NC 27831

(g) Mr. J. Wayne Griggs, President
Tennessee Agricultural Council
Route 5
Humboldt, TN 38343

(h) Mr. B. F. Smith
Executive Vice President
Delta Council
Stoneville, MS 38776

(i) Mr. James R. Carte
Executive Vice President
Arizona Cotton Growers Association
4139 East Broadway
Phoenix, AZ 85040

(j) Mr. J. D. Hays, President
Alabama Farm Bureau Federation
P.O. Box 11000
Montgomery, AL 36111

(k) Mr. B. C. Mangum, President
North Carolina Farm Bureau Federation
P.O. Box 27766
Raleigh, NC 27611

(l) Mr. P. R. Smith, Chairman
Agricultural Commodity Commission for Cotton
P.O. Box 5958
Beechwood Office Building II
Athens, GA 30604

(m) Honorable Albert McDonald
Alabama State Senate
Huntsville, AL 35806

(n) Mr. Murray T. Walton
Louisiana Wild Life and Fisheries Commission
P.O. Box 44095
Capitol Station
Baton Rouge, LA 70804

(o) Dr. George Slater
Cotton Incorporated
3901 Barrett Drive
Raleigh, NC 27606

(p) Mr. Ritchie Smith
National Cotton Council of America
P.O. Box 12285
Memphis, TN 38112

(q) Mr. William H. Wyatt
800 West Main
Blytheville, AR 72203

(r) Mr. John K. Hosemann
American Farm Bureau Federation
225 Touhy Avenue
Park Ridge, IL 60068

(s) Mr. William A. Robinson
Virginia Farm Bureau
P.O. Box 97
Skippers, VA 23879

(t) Mr. Jess G. Stratton
515 South 14th Street
Clinton, OK 73601

(u) Mr. Robert A. Tucker
Executive Vice-President
Southern Cotton Growers
P.O. Box 866
Dahlonega, GA 30533

(v) Mr. R. King
Olin Corporation
Germantown, TN 38138

(w) Mr. G. Keathly
Arkansas Farm Bureau
7th at High Street
Little Rock, AR 72203

(x) Mr. Harry S. Bell
South Carolina Farm Bureau
P.O. Box 754
Columbia, SC 29202

(y) Mr. V. Glasson
Texas Farm Bureau
7420 Fishpond Road
P.O. Box 489
Waco, TX 76703

(z) Mr. Earl Younts
Cotton Board
P.O. Box 4948
Memphis, TN 38104

7. Individuals

(a) Dr. E. F. Knipling
Agricultural Research Service
Room 205-NAL
U.S. Department of Agriculture
Beltsville, MD 20705

(b) Ms. Judy Head
Chapter Coordinator
Bass Anglers Sportsman Society
of America
P.O. Box 3044
Montgomery, AL 36109

(c) Ms. Cynthia E. Wilson
National Audubon Society
National Capital Office
1511 K Street, NW.
Washington, DC 20005

(d) Mr. H. Paul Friesema
Center for Urban Affairs
Northwestern University
2040 Sheridan Road
Evanston, IL 60201

(e) Mr. Marc J. Hershman
Sea Grant Legal Program
52 Law Center
Louisiana State University
Baton Rouge, LA 70803

(f) Mr. Patrick Lee Reagan
Consultant
Minnesota Public Interest Research Group
3036 University Avenue Southeast
Minneapolis, MN 20250

(g) Mrs. Robert E. Burks, Jr.
The Alabama Conservancy
Conservation Center
1816-E 28th Avenue, South
Birmingham, AL 35209

(h) Mr. Kenneth Hampton
National Wildlife Federation
1412 16th Street, NW.
Washington, DC 20036

(i) Ms. Marni Holbrook
Isaak Walton League
1800 North Kent Street
Suite 806
Arlington, VA 22209

(j) Mr. Peter Wilson
National Wildlife Federation
1412 16th Street, NW.
Washington, DC 20036

(k) Mr. Robert J. Sutton
North Carolina Department of Agriculture
P.O. Box 4213
Raleigh, NC 27607

(l) Ms. Maureen Hinkle
Environmental Defense Fund
1525 18th Street, NW.
Washington, DC 20036

(m) Ms. Stephanie Harris
Health Research Group
2000 P Street, NW.
Room 708
Washington, DC 20036

(n) Ms. Nancy Benson
American Cyanamid
1625 Eye Street, NW.
Washington, DC 20006

(o) Mr. Dennis McCormick
American Cyanamid
1625 Eye Street, NW.
Washington, DC 20006

(p) Mr. Joe Linduska
National Audubon Society
1511 K Street, NW.
Washington, DC 20005

(q) Mr. Lonnie Williamson
Wildlife Management Institute
709 Wire Building
Washington, DC 20005

(r) Mr. Stan Cath
National Association of State Departments
of Agriculture
1616 H Street, NW.
Washington, DC 20006

(s) Mr. William L. Hollis
National Agricultural Chemical Association
1155 15th Street, NW.
Washington, DC 20005

(t) Dr. T. C. Byerly
American Association for Advancement
of Science
62 Ridge Road
Greenbelt, MD 20770

(u) Mr. Jerry W. Kennedy
National Cotton Council
Suite 700
1030 15th Street, NW.
Washington, DC 20005

(v) Ms. Bette Lou Fields
Environmental Studies Board
National Academy of Sciences
2101 Constitution Avenue, NW.
Washington, DC 20037

(w) Mr. J. E. Jernigan
Extension National Cotton Specialist
4466 Elvis Presley Boulevard
Suite 109
Memphis, TN 38116

(x) Dr. Walter K. Porter, Jr.
Mississippi Agriculture and
Experiment Station
Mississippi State University
Mississippi State, MS 39756

(y) Mr. Richard J. Sauer
Cooperative States Research Service
U.S. Department of Agriculture
Room 445-W
Washington, DC 20250

(z) Mr. Ernest E. Sligh, Director
Office of Environmental Programs
Federal Energy Administration
New Post Office Building
12th and Pennsylvania Avenue, NW.
Washington, DC 20461

8. Statements Mailed on Request

(a) J. Nelson Gibson
P.O. Box 66
Gibson, NC 28343

(b) J. Donald Kerr
Rt. 3
Waxhaw, NC 28173

(c) W. Glenn Toomey
458 Williams, NCSU
Raleigh, NC 27607

(d) Leroy Jackson
P.O. Box 2419
Raleigh, NC 27602

(e) Glenn Worley
1403 Varsity Drive
Raleigh, NC 27606

(f) Wilbur F. Kinlaw
Route #7
Lumberton, NC 28358

(g) Ernest E. Miller
P.O. Box 27327
Raleigh, NC 27611

(h) J. E. White, Jr.
Rt. 1, Box 231
Scotland Neck, NC 27874

(i) Clyde D. Peedin
County Extension Chairman
P.O. Box 37
Halifax, NC 27839

(j) R. L. Robertson, Ext. Ent.
2309 Gardner Hall, NCSU
Raleigh, NC 27607

(k) B. L. Flippen
Box 975
Emporia, VA 23847

(l) State of North Carolina
Office of Intergovernmental Relations
Department of Administration
116 W. Jones Street
Raleigh, NC 27611

(m) Wallace G. Johnson
Marketing Specialist
NCDA, Division of Markets
Raleigh, NC 27611

(n) Bill Dalton
USDA, APHIS
Washington, DC

(o) Ken Nolan
American Cyanamid Co.
Princeton, NJ

(p) Myra Culbert
American Farm Bureau
Washington, DC

(q) Connie Garner
Chemagro Corp.
Kansas City, MO

(r) Glen Loomis
USDA, Soil Conservation Service
Washington, DC

(s) Tom Grumbly
Office of Management and Budget
Washington, DC

(t) Ed Imai
USDA, APHIS
Washington, DC

(u) Carl Momberger
USDA, APHIS
Washington, DC

(v) Chester F. Phelps
Game and Inland Fisheries
Richmond, VA

(w) Clyde Patton
Wildlife Resources Commission
Raleigh, NC

(x) James A. Timmerman, Jr.
Wildlife & Marine Resources Dept.
Columbia, SC

(y) Velmar Davis
USDA, Economic Research Service
Washington, DC

(z) Murray Felsher
NASA
Washington, DC

(aa) Karen Vincent
National Cotton Council
Washington, DC

(bb) Fowden Maxwell
Secretary's Office
USDA
Washington, DC

(cc) Gerald Lowry
USDA, Environmental Services Division
Washington, DC

(dd) J. E. Slosser
TAES
Vernon, TX

(ee) W. T. Reece
ASCS
Raleigh, NC

(ff) Lawrence Heffner
USDA, Extension Service
Washington, DC

(gg) American Farm Bureau Federation
(Attention: Government Relations)
Washington, DC

(hh) Pamela Carter
National Wildlife Federation
Washington, DC

(ii) Robert Vanderbosch
University of California
Albany, CA

(jj) Fred Plapp
Texas A&M
College Station, TX

NATIONAL COTTON COUNCIL OF AMERICA
POST OFFICE BOX 12285 / MEMPHIS, TENNESSEE 38112
TELEPHONE: (901) 276-2783

September 22, 1975

Dr. James O. Lee, Jr.
Deputy Administrator
Plant Protection and Quarantine
APHIS - USDA
Washington, D. C. 20250

Dear Dr. Lee:

Re: Draft Environmental Impact Statement on Trial Boll Weevil Eradication Program

This is the response of the National Cotton Council to the draft environmental impact statement which was prepared for the trial boll weevil eradication program by APHIS - USDA in accordance with Public Law 91-190.

The Council is the central organization of the American cotton industry, representing cotton producers, ginners, merchants, warehousemen, cooperatives, cotton textile manufacturers, and cottonseed crushers in the 19 cotton-producing states.

Our general assessment of the statement is that (1) it is factual and comprehensive, (2) it provides clear evidence that the proposed program will yield extensive environmental and economic benefits, and (3) it confirms the urgent need to proceed promptly with the trial as the next and final step in finding an acceptable way to rid this nation of the most wasteful and expensive agricultural pest in U. S. history.

In responding to your notice of intent to prepare the environmental impact statement last October, we reviewed the seriousness of the boll weevil problem and suggested pertinent evidence that should be considered in developing the statement. A copy of my letter of October 23, 1974, is attached for your ready reference. In our view, all significant evidence is reviewed in the draft statement, and it clearly documents the case for eradication. While the projected benefits are substantial, they may well be on the conservative side. Thus, we would expect the real benefits from actual eradication to consumers, the environment, and the nation's economy to be even greater than those cited in the report.

We greatly appreciate the opportunity to offer these comments, and will continue to vigorously support efforts to get the trial program underway next year.

Sincerely,

Albert R. Russell

Albert R. Russell
Executive Vice President

Enclosure

National Cotton Council of America BOX 12285, MEMPHIS, TENNESSEE 38112

COMFORTABLE · CAREFREE COTTON

October 23, 1974

Dr. L. G. K. Iverson
Deputy Administrator
Plant Protection and Quarantine
APHIS - USDA
Washington, D. C. 20250

Dear Dr. Iverson:

Re: Draft Environmental Impact Statement on Proposed Boll Weevil Eradication Field Trial

This is the response of the National Cotton Council to the notice of intent to prepare an environmental impact statement on the proposed boll weevil eradication field trial (Federal Register, October 17, 1974).

The Council is the central organization of the American cotton industry, representing cotton producers, ginners, merchants, warehousemen, cooperatives, cotton textile manufacturers, and cottonseed crushers in the 19 cotton-producing states.

Since 1958, we have vigorously supported efforts to rid this nation of the boll weevil, the most wasteful and expensive agricultural pest in our history.

An alien insect, the boll weevil entered this country from Mexico over 80 years ago, and has since rendered serious economic, sociological, and ecological impacts in the boll weevil belt -- some 14 states in the South and Southwest. The direct cost to cotton growers alone has totaled over $12 billion; and annual losses, together with control costs, still average over $260 million.

The main method of control now available to growers requires the heavy year-to-year use of insecticides. Official government estimates indicate that boll weevil control now accounts for one-third of the insecticides used on all U. S. crops. The continued reliance on this control method will undoubtedly result in serious environmental and economic consequences, and an alternative solution is clearly in the public interest.

The compelling alternative is to perfect and to utilize the newly developed combination of biological, cultural, and chemical techniques which have the capability of eradicating this devastating insect in the United States. The cost of eradication will be infinitely small when compared with the ecological and economic benefits that will accrue.

We strongly support the Department's proposed eradication field trial covering the Virginia-Carolinas area to refine techniques and operations and to determine the feasibility of moving ahead with a national eradication program.

We urge the Department to include in the draft environmental impact statement required by the National Environmental Policy Act of 1969 pertinent documentation of the expected impact of the proposed field trial program on the environment in the area. We are confident that data from the Pilot Boll Weevil Eradication Experiment and other recent research will fully confirm that the proposed program will enhance and improve the environment in the area, both during the short term of program operations, and especially for the continuing long term after eradication is achieved. Upon receiving your draft statement, we will offer further specific comments considered germane to its content.

We are most anxious to assist and cooperate in every possible way in the trial program and the subsequent national program, assuming the trial demonstrates its expected feasibility. We are painfully aware that the boll weevil adds to environmental concerns, aggravates other insect problems, and hampers the productivity of the cotton industry by reducing production of needed cotton and cottonseed and causing a tragic waste of energy, chemicals, labor, time, and money. In our view, eradication of the insect is clearly in the interest of consumers and the nation, as well as American agriculture.

Sincerely,

Albert R. Russell
Executive Vice President

ARR:plp

THEODORE CARROLL BYERLY
6-J RIDGE ROAD
GREENBELT, MARYLAND 20770

August 28, 1975

To
Administrator Frank Mulhern
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
Washington, D.C. 20250

Subject: Draft environmental statement--Trial Boll Weevil Eradication Program

My comments on the statement follow. They are solely my own and do not necessarily reflect the views of AAAS which organization I represented at the March 5 briefing.

T C Byerly

Page 2, lines 10-13.
I suggest rewording as follows: "Since initiation of the reproduction-diapause control program, the boll weevil has not spread farther west."
Reason: the present statement is subject to the fallacy post hoc ergo propter hoc, i.e. it is argument after the fact; there was no control.

Page 2, line 19.
Is the \$50-\$75 million estimate for the cost of insecticides or does it inclued cost of application?

Page 9, line 7.
The statement on chlorinated hydrocarbon insecticides may be misleading. Which such insecticide ever was effective against the boll weevil?

Page 10.
The inference that boll worms may be controlled by biological agents after the boll weevil is eradicated may be difficult to support. Expense of repeated dispersion and artificial propagation of such agents may be prohibitive.

Continued--

Page 11, lines 5-8.
The statement is a value judgment, irrelevant and should be omitted.

Page 20, line 21.
Insert word "mandatory" after number "3".

Page 23.
Last sentence should be reconciled with statements on reproduction diapause control in the preceding paragraph.

Page 25, line 8.
What is "farmer cotton"?

Page 29, line 11.
Insert "monitoring" after research.

Page 30, point 7b.
I question the need for this point. Since wild cotton exists there and is a recognizrd host, this item seems redundant. See page 5, line 8.

Page 32, line 13.
"Thompson Hayward 6040" should be given its chemical name and reference to published information that it is "onmutagenic" should be cited.

Page 33, line 22.
Isn't it likely that bollworm control in cornfields near cotton will be necessary?

Page 45, line 7 <u>et seq</u>.
I question the appropriateness of this undocumented statement of "boll weevil experts" concensus. Document it or delete it. A "no chemical" basis seems appropriate, but the estimates (Table 2, page 69) appear to lack an empirical data base.

Page 47, line 8 <u>et seq</u>.
I suggest reword as follows: "Research and monitoring results indicate that local population of a few nontarget organisms are likely to be sdversely affected. There is no evidence that significant irreversible or irretrievable commitments of resources will occur." The last sentence of the paragraph seems to me to be fallacious; isn't upland cotton an introduced species, at least in the areas affected by boll weevil?

Page 48, lines 12-14.
This statement is inadequate. "Every reason to believe" should be supported at least briefly with a statement of those reasons.

State of North Carolina

Wildlife Resources Commission

RALEIGH, N. C. 27611

September 9, 1975

Dr. Francis J. Mulhern
U. S. Department of Agriculture
Room 316-A
Washington, D. C. 20250

Dear Dr. Mulhern:

We have reviewed the Draft Environmental Statement for Trial Boll Weevil Eradication Program through chemical, cultural, sex attractant and regulatory procedures.

While we remain somewhat apprehensive of the impact of the massive chemical treatment proposed during the first year of the program, this may be more than compensated by substantially reduced needs for chemical treatment in subsequent years if the trial is successful.

If the project is approved, we will appreciate being notified so that we might alert certain of our personnel and associates, and solicit their observation of impact, if any, upon fish and wildlife.

Presumably, if the procedure is effective, it will continue to control the weevil even if additional acreage is dedicated to cotton because of its improved income status.

Sincerely,

Frank B. Barick

Frank B. Barick
Chief, Interagency Wildlife
Coordination Section

FBB/en

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

1421 PEACHTREE ST., N. E.
ATLANTA, GEORGIA 30309

November 11, 1975

Dr. F. J. Mulhern
Administrator, Animal and Plant
Health Inspection Service
Room 316-A
U. S. Department of Agriculture
Washington, D. C. 20250

Dear Dr. Mulhern:

We have completed our review of the Draft Environmental Impact Statement for the Trial Boll Weevil Eradication Program in Virginia, North Carolina and South Carolina and find we have reservations concerning environmental effects of the proposed action.

The concept of integrating chemical, biological and cultural control of the boll weevil is a step in the right direction for a great reduction of insecticide usage. Environmental conditions which ocurred in the Mississippi pilot test area are not representative of those which occur in Virginia, North Carolina and South Carolina. Therefore, it is imperative that a biological monitoring program be implemented to measure the impact of the proposed program on non-target organisms during the initial phase. If data from the biological monitoring program indicates a severe impact on non-target organisms on the initial 100,000 acres in Virginia and North Carolina, then the program should be re-evaluated and changes made, or if necessary, terminated. As an alternative, a trial in Virginia-North Carolina area involving less acreage should be explored.

Given the deficiencies of the Mississippi trial, it is apparent that much greater emphasis must be placed on educating growers regarding their role in the proposed program. It would have been valuable to measure farmer acceptance in a more detailed evaluation, since their full participation is necessary for an eradication program. Also, since there are other common pests of cotton, there is a need to know how pesticide applications for other pests would or would not affect the boll weevil program. There is a need to know how pesticide applications to other crops grown in the eradication zone affect the boll weevil program.

The draft EIS pointed out that the effectiveness of each individual suppression component is dependent on the effectiveness of the preceeding one. However, alternate proposals in the event of failure of one of the suppression components was not discussed.

The DEIS discusses the effectiveness of aldicarb as a systemic insecticide used on the trap crops in Mississippi. Is aldicarb to be used in the Virginia-North Carolina program? Placements of trap crops should be carefully considered assuring the possible run-off from the trap crop does not contaminate aquatic sites. ULV application effectiveness should be compared with ground applications to determine most effective methods of application.

We strongly urge the development of qualifications to show competence in the aerial application of ULV insecticides to cotton. All States will soon be training and certifying applicators who apply restricted-use pesticides. Applicators using aldicarb and azinphosmethyl (Guthion) will need certification in the State in which it is applied. State regulatory personnel should be contacted for changes in State and Federal laws.

In view of the foregoing we have assigned a rating of ER-(Environmental Reservations) to the project and 2 (Insufficient Information) to the Statement.

Please furnish us with five (5) copies of the final EIS when it becomes available. If we can be of further service, please let us know.

Sincerely,

for John A. Little, Deputy

Jack E. Ravan
Regional Administrator

WILDLIFE MANAGEMENT INSTITUTE

Dedicated to Wildlife Restoration
709 WIRE BUILDING, 1000 VERMONT AVENUE, WASHINGTON, D. C. 20005 (202) 347-1774

August 6, 1975

Dr. Francis J. Mulhern
U.S. Department of Agriculture
Room 316-A
Washington, D.C. 20250

Dear Dr. Mulhern:

We appreciate the opportunity to comment on the draft environmental impact statement prepared for USDA's trial boll weevil eradication program in areas of Virginia, North Carolina, and South Carolina.

The draft EIS, in our opinion, is adequate. There is, however, one question that should be clarified. The statement does not specify how boll weevil eradication would be achieved in host plants outside cotton fields. Chemical treatment measures evidently would be directed only at cotton acreage. It appears that program designers intend for grandlure traps, trap crops, and sterile weevils to handle that problem, but the EIS should have an additional paragraph stating specifically how it is to be solved.

Host plant involvement would not be as serious in the Virginia, North Carolina, South Carolina trial area as it would along the Gulf Coast where preferred host plant alternatives are more prevalent. Nonetheless it is a possible problem and should be covered in the current EIS.

We note that the wildlife agencies of those states involved were not included on the list receiving review copies of the draft statement. That is a serious oversight, in our view, because the fish and wildlife resources for which those agencies are responsible could be effected by the proposed eradication attempt. Those state agencies, especially the North Carolina Wildlife Resources Commission, have experienced considerable problems with adverse pesticide impacts on fish and wildlife.

Even though overall pesticide use and the expected adverse impacts would be less with the eradication program than with normal farmer applications, some things would be done differently. The state fish and wildlife agencies may wish to monitor selected animal populations to determine the program's effects on certain wild species.

In any event, the knowledge and experience of state wildlife agency personnel could be valuable to the program's success and as well as to the protection of fish and wildlife resources in the test area.

Therefore copies of the EIS and requests for comments should be sent to Chester F. Phelps, executive director, Commission of Game and Inland Fisheries, Box 11104, Richmond, Virginia 23230; Clyde Patton, executive director, Wildlife Resources Commission, P. O. Box 27647, Raleigh, North Carolina 27611; and James A. Timmerman, Jr., executive director, Wildlife and Marine Resources Department, Box [illegible]

Sincerely,

Lonnie L. Williamson

Lonnie L. Williamson
Secretary

LLW:bsm

cc C. Phelps
C. Patton
J. Timmerman

Air Mail

September 26, 1975
542 Piezzi Road
Santa Rosa CA 95401
Phone (707) 542-6904

Mr. J.F. Spears
Acting Deputy Administrator
Plant Protection and Quarantine Programs
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
Washington D.C. 20250

Dear Mr. Spears:

Enclosed are comments I have prepared in response to the document, Trial Boll Weevil Eradication Program, Draft Environmental Statement (USDA-APHIS, ADM-75-1)), dated July 25, 1975.

I also am distributing copies of the comments to several of my cohorts who have interests in the proposed boll weevil eradication program.

Sincerely,

Dale G. Bottrell

Dale G. Bottrell
Private Entomological Consultant

enclosure: 1

COMMENTS ON THE "ENVIRONMENTAL DRAFT STATEMENT FOR TRIAL BOLL WEEVIL ERADICATION PROGRAM" (USDA-APHIS, (ADM)-75-1), DATED JULY 25, 1975

by Dale G. Bottrell
Private Entomological Consultant
542 Piezzi Road, Santa Rosa, CA 95401

QUALIFICATIONS OF RESPONDENT

Present Position

Since March 1, 1975 I have been engaged in independent, freelance entomological consulting work. I am a professional entomologist registered in "Pest Management" by the American Registry of Professional Entomologists. My primary interest in entomology is pest management and population dynamics, however, I have a broad range of experience in several areas of entomology and am interested in various aspects of consulting work available through universities, other state and federal agencies and private business.

Although presently engaged in some contract work funded by the University of California, I am not permanently affiliated with this University or any other public agency or private business sector. I prepared the comments herein on my personal time and at my personal expense. These comments present my own opinion on the Boll Weevil Eradication Program and not necessarily the opinion of the University of California or any other public agency or private business sector.

Experience and Familiarity With the National Boll Weevil Problem

I do have considerable familiarity with the national boll weevil problem. This familiarity has been gained through several years of research on the pest and from experience gained while serving on several state and national committees, task forces and coordinative assignments focusing specifically on boll weevil research and control

technology. All of my experience on the boll weevil came while I served on the staff of Texas A&M University from August 1, 1967 to February 28, 1975. Below is a breakdown of my past experience with the boll weevil which qualifies me to comment herein on the 3-year Trial Boll Weevil Eradication Program proposed for Virginia, North Carolina and South Carolina.

1. From August 1, 1967 to December 31, 1971 I was principal research entomologist with the Texas Agricultural Experiment Station in charge of boll weevil investigations in the High and Rolling Plains of Texas. During this period, I had major responsibilities in developing research to complement suppressive and evaluative techniques employed in the "High Plains Reproduction-Diapause Boll Weevil Control Program". This large-scale boll weevil suppression program in West Texas, initiated in 1964 and continued every year since (1)*, produced much of the prototype technology and implementation procedures adopted in the "Pilot Boll Weevil Eradication Experiement" centered in southern Mississippi in 1971-73 (2).

2. In addition to my research role in the High Plains boll weevil program I served on the Technical Advisory Committee in charge of evaluating the program's progress. This role coupled with my research role in this large-scale program gave me a good insight into the technological problems involved in boll weevil suppression. Several major experiments cited (3,4,5) in the subject publication, "Draft Environmental Statement for Trial Boll Weevil Eradication Program", in support of demonstrating the effectiveness of certain suppression components proposed for boll weevil eradication were superimposed in this program. Thus, I had a first-hand opportunity to review the results of these experiments which have molded many of the concepts

*Citations noted by number appear at the end of this submittal.

and rationale underlying the current boll weevil eradication proposal.

3. In 1971, upon initiation of the Pilot Boll Weevil Eradication Experiment centered in southern Mississippi, the Cooperative States Research Service (USDA-CSRS) awarded several research grants, ancillary to the Pilot Experiment and in support of complementary research on various concepts and techniques related to boll weevil eradication. I was a principal co-investigator of one of the grants which focused on the boll weevil problem in the High and Rolling Plains of Texas.

4. From Janurary 1, 1972 until my resignation from Texas A&M University on February 28, 1975, I served as principal investigator of a large interdisciplinary cotton insect pest research project headquartered at the University's main campus. All of my personal research on this project was focused on boll weevil population dynamics and control, and a major portion of the overall project was on the development of improved boll weevil suppression technology. Also during this time, I served on several county, regional and state-wide committees and task forces in charge of organizational and implementative aspects of boll weevil control.

5. I participated in many of the meetings of the "Technical Guidance Committee" of the Pilot Boll Weevil Eradication Experiment (co-chaired by Drs. J.R. Brazzel and E.F. Knipling) which reviewed the progress of the Pilot Eradication Experiment centered in south Mississippi. I also made several on-location tours of the experimental area in Mississippi during the course of the Pilot Experiment.

6. I participated in several meetings of the "Technical Subcommittee to Develop an Overall Plan for Boll Weevil Eradication" (Dr. E.F. Knipling, Chairman, and Dr. J.R. Brazzel, Vice Chairman) which was formed in 1973 to explore the feasibility of a national boll weevil eradication program.

7. I was a member of the "Subcommittee for Insecticides for Boll Weevil Eradication" (Chaired by Dr. E.P. Lloyd) which was appointed by Dr. E.F. Knipling to review research on insecticides used for boll weevil control and to develop recommendations concerning insecticidal control of boll weevil in a national eradication effort.

8. I was a member of the 1973 Task Force in charge of developing a recommendation for long-range national cotton insect research (6).

The above experience exposed me to the great many complexities of the national boll weevil problem and the modern technology which has been advanced to cope with this problem. There can be no doubt that this technology has produced concepts and techniques which have led to a more scientific basis for boll weevil control. Technology emerging the past decade on boll weevil control should serve as an unprecedented example of the progress that can be made when the scientific community joins forces in dealing with a national problem that affects the lives and economy of broad segments of society. Unquestionably, as the subject "Draft Environmental Statement" clearly points out, the boll weevil is a serious burden to the national economy not only in terms of the losses it afflicts to cotton but also in terms of the pesticidal pollution resulting from efforts to control the pest. In spite of the past decade's tremendous advancement in boll weevil technology, this pest still presents one of the most complex, challenging problems confronting the U.S. cotton industry and the U.S. scientific community. And I've become fully convinced from a great deal of experience on the research and control of the pest that the national boll weevil problem can be best approached via a large-scale organized effort that embraces the fullest cooperation of all scientists, regulatory agencies, control agencies and the cotton industry sector of a

given geographical region or closely related regions. The tremendous migratory characteristic of the boll weevil is reason in itself to dictate the need for an organized geographical regional effort as opposed to an individual cotton farmer effort. And since the boll weevil problem encompasses the welfare of a broad segment of society in addition to the private cotton industry sector, I believe it is in the national interest to utilize public tax dollars in the support of the organization and implementation of boll weevil suppression efforts that are undertaken to deal with the problem on a regional or national basis.

Thus, I do not question the logic, which appears very sound to me, in attacking the boll weevil problem on a large-scale basis as outlined in the Trial Eradication Experiment proposed for Virginia and the Carolinas. And I believe that if available eradication technology were proven feasible, beyond doubt, eradication might be a desirable goal if the boll weevil could be eliminated permanently from the U.S. at a cost (dollars plus all other considerations) that benefited our total society on the long haul.

Hopefully, I have made it clear that I do not necessarily oppose the strategy or philosophy of eradication per se. I do believe, however, that eradication of the boll weevil in this country, i.e., complete elimination in the U.S., is a goal that current technology cannot carry to fruition. I also believe that certain entomologists, segments of the cotton industry and also certain research and regulatory agencies who are currently promoting the concept of boll weevil eradication concur fully with me, i.e., eradication is a goal beyond the scope of current technology. However, either because of their inherent unethical nature, because of pressure from their administra-

tors or agencies or because of politically motivated reasons, these persons or agencies have assumed a role of hypocrisy in promoting the boll weevil eradication program. That is, they are promoting a program which they feel has little chance for success but which offers to produce benefits for them or their agencies to reap.

It is my firm opinion that the research scientists and the regulatory personnel involved in this hypocritical promotion of boll weevil eradication are committing a most serious violation of scientific ethics, and their action portends to cause irreparable damage to the scientific community's credibility as viewed by the American public. Interestingly, I am not the only one who is concerned about the possible irreparable damage that premature implementation of a U.S. boll weevil eradication effort might cause. The attached dissenting view (Attachment I) was presented at the "Conference on Boll Weevil Management and Elimination Strategies" held in Memphis, Tennessee in February 1974 to review the overall national progress on boll weevil suppression as related to eradication technology. It is significant that, though the Subject Draft Environmental Statement of July 25, 1975 fails to mention this dissenting statement, the statement in Attachment I represented the views of the principal cotton entomologists in attendance of the Conference from the Land Grant Universities of Texas, Arkansas, Mississippi, Louisiana, Alabama and Georgia---major cotton states of the South where the boll weevil is a pest!

The purpose of my response to the subject "Environmental Draft Statement" dated July 25, 1975 is (1), to point out some very obvious shortcomings in the present technology related to boll weevil eradication that I feel the subject Statement intentionally failed to discuss, and (2), to cite examples in support of my earlier allegations

that promoters, some of whom are intimately involved in the trial program proposal for Virginia and the Carolinas, are committing a most serious violation of scientific ethics.

I shall not attempt to address the whole subject of boll weevil eradication since I have no expertise whatsoever in the sterile male component and certain other aspects of eradication. However, I am fully qualified to address the subjects I have selected here and am prepared to back up all of my claims and allegations with factual information if any one cares to challenge all or part of the material herein.

I have no professional motives in presenting the dissenting views herein and no personal motives either, other than personal satisfaction in knowing that I have at least tried to prevent the cotton industry and the public from buying a bill of goods which is being sold by a few persons with sole motives of promoting themselves professionally or the welfare of their agencies. I am no longer a member of the scientific research community and, thus, am not competing for research grants for myself or for my research agency. Actually, I would be better off in terms of the welfare of my future consulting plans if I just kept "shut up" about the boll weevil eradication program. Because my comments herein are likely to make me extremely unpopular among certain agencies and other sectors involved in the boll weevil eradication program—sectors that offer competitive contracts to private consultants like myself.

OUTCOME OF THE RECENT PILOT BOLL WEEVIL ERADICATION EXPERIMENT

As stated in the subject "Draft Environmental Statement" dated July 25, 1975 two technical committees were in charge of responsibilities for evaluating results of the Pilot Eradication Experiment centered in southern Mississippi. Neither of these committees, after

considerable deliberation on the outcome of the Experiment, concluded that boll weevil eradication was achieved in this experiment. The Entomological Society of America Review Committee concluded that "Data available at the termination of the experiment indicate that eradication was not accomplished in the core area" (p. 179-182, Appendix D, of the subject "Draft Environmental Statement" dated July 25, 1975). The Technical Guidance Committee for the Pilot Boll Weevil Eradication Experiment concluded that..."it is technically and operationally feasible to eliminate the boll weevil as an economic pest in the United States by the use of techniques that are ecologcially acceptable" (p. 177-178, Appendix C, subject "Draft Environmental Statement" dated July 25, 1975).

The first committee expressed reservations concerning any massive eradication undertaking without further research to refine suppression techniques. And the second committee, in spite of its conclusion above, did not claim that eradication per se (i.e., complete elimination of every last boll weevil) was possible in the U.S. Rather, this committee simply stated that it was technically and operationally feasible to eliminate economically damaging populations of this pest.

Hence, the single largest experiment yet conducted to test out the feasibility of boll weevil eradication with the most modern technology failed to produce results which allowed the two evaluative committees in charge of the experiment to conclude that eradication had been achieved in the experiment or that eradication was feasible in the U.S.

I agree fully with the conclusion of the second committee. It probably is highly feasible via currently available suppression techniques to eliminate the boll weevil as an economic pest of the United States. In fact,this probably could be done with reproduction-diapause boll weevil control alone, a technique which has been shown to

be ecologically acceptable. This approach has been used successfully as the sole component in the "High Plains Reproduction-Diapause Control Program" mentioned above and has eliminated the boll weevil as an economic pest every year since the program's inception in 1964! The only problem with this type of strategy to eliminate economic damage is that the elimination tactic must be repeated every year, so long as economic damage is to be eliminated, and can never be expected to eliminate the pest species itself.

The true meaning of the word "elimination" as interpreted by the "Technical Guidance Committee" has not been appropriately explained to a broad segment of public policy makers in charge of allocating resources for boll weevil eradication. The Committee's conclusion, however, has been conveyed by promoters of boll weevil eradication to imply that the species itself can be eradicated (or eliminated) from the U.S.!

THE PHEROMONE TRAP MYTH

The subject "Draft Environmental Statement" dated July 25, 1975 states that pheromone traps and pheromone trap crops are an important component in the proposed boll weevil eradication program. There is no doubt that these techniques have proved extremely valuable in population surveillance as evident by results of the Pilot Experiment centered in southern Mississippi and results from numerous other experiments which have evaluated these techniques. However, the exact role of the pheromone traps as a suppressive technique for controlling the boll weevil was not determined in the Pilot Experiment centered in southern Mississippi. And data from other experiments which have employed pheromone traps also fail to provide reliable quantitative information on the value of pheromone trapping in suppressing boll weevil populations. Dr. D.R. Rummel and I recently conducted an evaluation of

the "State of the Science" of pheromome trapping for control of the boll weevil in Texas and other parts of the weevil-infested Cotton Belt. In this evaluation, we strongly challenged the value of pheromone traps and pheromone trap cropping for suppression of the boll weevil. We questioned the whole validity of the evaluative techniques which have been employed to derive estimates of the efficiency of traps in suppressing weevil populations. We concluded that none of the evaluative studies has provided valid quantitative information on the actual, let alone the potential, trap suppression of the weevil. Furthermore, it is doubtful that present methods of using trap crops, which employ early-planted trap rows fortified with synthetic pheromone, are pratical in much of the Cotton Belt.

Yet, the subject "Draft Environmental Statement" dated July 25, 1975 clearly states on p. 24 that "Trap efficiency in capturing boll weevils at low population densities is near 80 to 90 percent". This claimed suppression is totally unwarrented based on results of experimental techniques which have been employed to derive population suppression estimates. Traps obviously are effective in capturing boll weevils, but their significance in actual population suppression has yet to be determined with any confidence. Nevertheless, the "Draft Environmental Statement" dated July 25, 1975 states that each suppression component (the pheromone trap is proposed as one of the components) is important in achieving eradication, and each must be applied to every cotton field in the area (the eradication area).

The pheromone trap and trap crop principles have many desirable features as suppressive components in insect control programs, i.e., they are selective against the target pest, non-polluting, etc. However, how can their employment be justified until appropriate research has been conducted which demonstrates their unequivocal value in

population suppression? Is it possible that boll weevils responding to the traps are merely suicidal emergers or genetic variates that do not actually contribute to the boll weevil infestations in cotton? Do all strains or geographical races of the boll weevil respond to pheromone traps? (There is substantial information from the Winter Garden area of Texas to question whether or not boll weevils in this area exhibit the trap response pattern typical of other areas of the U.S.).

Until these questions regarding the value of pheromone traps are answered and until a more practical method of pheromone-trap cropping has been developed, the inclusion of pheromone traps as suppression techniques in an eradication effort is highly questionable.

INSECTICIDES EMPLOYED IN THE PROPOSED BOLL WEEVIL ERADICATION PROGRAM

A major objective of boll weevil eradication is to reduce the insecticide load in the environment. There is no doubt that achievement of boll weevil eradication would result in a great reduction in the amount of insecticides now applied to the cotton ecosystem. Ironically, however, during the course of applying the eradication measures, much of the U.S. weevil-infested cotton would be exposed to much greater amounts of insecticide than ever before. Experts of the sterile boll weevil principle agree that insecticide would be an absolutely necessary first step to reduce the boll weevil population to a population density sufficiently low for proper application of the sterile male technique. Although, as stated above, the role of the pheromone trap is unknown, proponents of the trapping principle agree that low population density achieved via insecticide application is a prerequisite to effective trap suppression.

An eradication effort would entail a great many applications of insecticides to every cotton field in a large treatment zone. In due process, the total boll weevil population likely would be exposed to

far greater selective pressure than ever before. It is not the duration of time to which a pest population is exposed to a toxicant that is most important in the selection of resistant individuals but the intensity of the selective pressure applied and the percentage of the total population exposed.

Hence, the outlined insecticidal-treatment strategy proposed for the Trial Boll Weevil Eradication Program in Virginia and the Carolinas is likely to expose the boll weevil population to intense selective pressure which favors the emergence of an O-P-(organophosphorus) resistant strain. This may or may not prove to be a factor of hazardous consequence. Nevertheless, it must be remembered that the proposed Trial Program is inherently designed to impose more selective pressure than ever applied to the boll weevil population inhabiting the area selected for Virginia and the Carolinas. True, this population has already been exposed to heavy O-P pressure but never the intensity of pressure which would result in an eradication effort.

Furthermore, one of the candidate insecticides (azinphosmethyl) proposed for the Trial Eradication Program poses a great hazard to human health. It appears that it is a moral obligation of agencies involved in tax-supported programs, such as the proposed Trial Eradication Program, to exercise extreme caution in selecting pesticides that cause minimal danger to operational personnel and other humans exposed to insecticidal treatments. Hence, there appears to be no justification in using azinphosmethyl in lieu of the other candidate insecticide, malathion, in the proposed Program for Virginia and the Carolinas, especially in view that efficacy data are lacking which show the superiority of the former toxicant as a boll weevil control.

WHAT IS THE PROPOSED TRIAL TO ACCOMPLISH?

The proposed action of the 3-year trial boll weevil eradication

program in Virginia and the Carolinas is stated (in the 2nd unnumbered page of the subject Draft Environmental Statement dated July 25, 1975) "to determine if the technical and operational requirements for eradication (of the boll weevil) can be executed successfully in a large-scale operational program". What then, does this program propose to accomplish that the Pilot Boll Weevil Eradication Experiment centered in southern Mississippi failed to accomplish?

The Pilot Experiment centered in southern Mississippi did <u>not</u> produce results which allowed the quantification of boll weevil suppression provided by each of the various integrated components (insecticides, pheromone traps, trap crops, sterile males). And the influence of immigration of boll weevils into the "core" eradication zone and their role in the suppression achieved was not determined. What assurance is there that the program proposed for Virginia and the Carolinas will be adequately designed so as to determine the role of the individual suppressive components and the influence of immigration? Unless this assurance can be granted with a high level of probability, it appears that the currently proposed program has been prematurely conceived and will produce little new information regarding boll weevil eradication.

THE QUESTIONABLE CREDIBILITY OF RESULTS FROM THE PROPOSED ERADICATION PROGRAM

I had the fortunate opportunity while on the staff of Texas A&M University to make the acquaintance of many knowledgable and sincere entomologists and administrators in charge of various aspects of the national boll weevil program of research and control. I do believe that the great majority of these individuals have strong convictions in their respective roles of research, regulation, control and administration. Although I disagree philosophically with certain of these

persons, I have a great deal of respect for the great majority of them.

Unfortunately, however, as I stated at the front of this submittal, I strongly question the professional and personal motives and ethics of some of the promoters of boll weevil eradication.

And I present herein an example which has led to my firm belief that certain individuals intimately engaged in the boll weevil eradication program have employed extremely unethical, personally motivated tactics in their promotion of certain components of eradication. It is not my intent to personally degrade those individuals I cite by name herein but, rather, to point out that they may not have the true interest of society at heart in their future role on the boll weevil eradication program. I would only hope that responsible, mature scientists and scientific administrators interpert my intent no differently. If they do, I am fully prepared to answer to what they might interpert as unethical procedures on my part.

Two of the APHIS personnel with primary responsibilities of the operational aspects of the Pilot Boll Weevil Eradication Experiment centered in southern Mississippi and also with primary responsibilities on the operational aspects of the proposed program for Virginia and the Carolinas are Mr. W.J. Boyd, Jr., and Dr. J.R. Brazzel. Attached (Attachment II) is a memorandum, dated September 3, 1973, in which I charged these persons of presenting an unwarrented, biased argument in support of the role of pheromone traps in suppressing boll weevils in a large-scale experiment conducted in West Texas in 1969 and reported in the Journal of Economic Entomology (Boyd et al. 1973, 66 (2): 507-510). Neither of these individuals responded to this charge, but I didn't really expect them to since I presented them with hard facts which I don't believe they could have denied.

The article cited above presented a strong argument on the merits

of employing pheromone traps to suppress overwintered boll weevil populations. However, the authors made no effort whatsoever to review in their paper other information, available from the same experimental area, which would have counteracted this argument. This could not have been the result of an oversight on their part since the counteracting information was as available to them as was the information that they cited in support of their (Boyd et. al.) argument. For obvious reasons, the authors did not ask me or any other entomologist of the Texas Agricultural Experiment Station to review the pre-published manuscript of the cited paper. However, they did list this Station as a cooperator in the 1969 West Texas Experiment reported in their paper. I should mention that the physical cooperation between the individuals of APHIS and personnel of the Texas Station was excellent throughout all of this 1969 experiment, and this same cooperative relationship prevailed during all other efforts between the two agencies.

Although the paper cited above presents a highly biased, unfounded argument in support of the pheromone trap's role in boll weevil suppression, persons on the "ground-floor" of the experiment, including researchers other than myself, have little faith in the paper's content. The unfortunate consequence, however, has more serious implications. For results of the experiment reported in the paper have been cited many times (including in the Draft Environmental Statement dated July 25, 1975) as evidence of the powerful role of pheromone traps in boll weevil suppression. Only an extremely unqualified scientist would accept these results as presented. But the non-technical audience, including the cotton industry and the general public, is more often than not handicapped in evaluating results conveyed by a scientist.

The first two authors (Boyd and Brazzel) of the cited article proved, in the course of writing this article, that they are not beyond

exercising unethical scientific tactics in reporting on the outcome of experiments, such as the one conducted in West Texas in 1969, which entail large sums of public agency and/or private industry support. Why then, would these same individuals be expected to exercise any different tactics in reporting on the outcome of the Pilot Boll Weevil Eradication Experiment conducted in southern Mississippi and adjoining states in 1971-73 or the Weevil Eradication Program scheduled for Virginia and the Carolinas?

The example just cited is merely a case where certain individuals have set out to elevate their own image or the image of their agencies at the expense of jeopordizing the credibility of the scientific community.

SUMMARY

I do not feel that it is my responsibility as an independent consultant to propose an alternative to the proposed Eradication Program or to present an argument against the concepts of eradication per se. I do feel, however, that all policy makers in charge of any aspect of the proposed eradication program are fully committed with a responsibility to the scientific community, the cotton industry and the general public to examine all of the facts, pro and con, regarding the proposed eradication program for Virginia and the Carolinas and the alternatives presented in the subject Draft Environmental Statement dated July 29, 1975.

Signed: Dale G. Bottrell 9/26/75
Dale G. Bottrell Date

REFERENCES

1. Rummel, D.R., et al. 1975. An appraisal of a 10-year effort to prevent the westward spread of the boll weevil. Bull. Entomol. Soc. Amer. 21 (1): 6-11.

2. Eden, W.G. (Chm.) 1973. The pilot boll weevil eradication experiment. (Report of the Entomological Society of America Review Committee). Bull. Entomol. Soc. Amer. 19 (4):218-221.

3. Boyd, F.J., Jr., et al. 1973. Spring destruction of overwintered boll weevils in West Texas with wing traps. J. Econ. Entomol. 66 (2): 507-510.

4. Hardee, D.D., et al. 1971. Suppression of populations of boll weevils over a large area in West Texas with pheromone traps in 1969. J. Econ. Entomol. 64 (4): 928-933.

5. Edwards, R.R, et al. 1974. Evaluation of trap crops and different trap crop treatments for suppression of boll weevil populations. J. Econ. Entomol. (in preparation).

6. Anonymous. 1973. The 1973 national cotton research task force report. 153 p.

1. It has been stated that both the ESA and Technical Guidance Committees have expressed reservations of eradication but this thought is not being communicated adequately to the producer and public. Elimination is being used to mean the same as eradication but the Technical Guidance Committee indicated that something less than eradication was achieved, i.e., "...elimination of the boll weevil as an economic species...". This point is of grave concern to a number of scientists who will be responsible for implementing the proposed program. We feel the program, based on present data, has obvious weaknesses especially in the areas of mass rearing and sterile release. It, therefore, seems rather presumptious for us to insinuate that we have the technology to eradicate (eliminate) the boll weevil from the United States.

2. We are concerned about the proposed investment that would be made on an eradication (elimination) research effort that appears premature. For example, nothing has been stated relative to the possibility that the program may not go according to schedule. If it does not, which will most likely be the case, how will the proposed budget be adjusted? In case serious errors in judgment have been made, how much will other areas of much needed research be sacrificed budget-wise to continue the eradication (elimination) program?

3. We feel that if we start prematurely our chances of success will indeed be slim and, with failure, the confidence of the American public in agricultural research will be damaged irreparably.

(The above statement was prepared by 8 entomologists representing the Land Grant Universities of Texas, Arkansas, Mississippi, Louisiana, Alabama and Georgia and read at the "Conference on Boll Weevil Management and Elimination Strategies", February 15, 1974, held in Memphis, Tennessee).

TEXAS A&M UNIVERSITY
COLLEGE OF AGRICULTURE
DEPARTMENT OF ENTOMOLOGY
COLLEGE STATION, TEXAS 77843

Instruction-Research-Extension Phone 845-2516

MEMORANDUM September 3, 1973

TO: Mr. F. J. Boyd, Jr.
Dr. J. R. Brazzel

FROM: D. G. Bottrell

For sometime I have wanted an opportunity to discuss with you one of the articles you published in this April's Journal of Economic Entomology: Boyd et al. "Spring destruction of overwintered boll weevils in west Texas with wing traps." I had hoped that schedules would have allowed us to discuss the paper in Lubbock last week. But I didn't think we really had enough time together to discuss the paper in depth, and, besides, I didn't think all persons present at the meeting should have been included in this discussion. Since I may not have a chance to see either of you for a while, I shall try here to touch on those items in your paper that I wanted to discuss with you.

Your paper brought back some fond memories of my job at Lubbock. I recall the many long, but pleasurable, hours that extremely dedicated people put into the 1969 trapping experiment. Unrefutably, this experiment could be cited as a model of how a large group of people with several different agencies can work together, if they so choose, to implement a pest control program of extremely huge dimensions.

You may interpret later comments in this memorandum as my being highly critical of the technical aspects in the conclusions of your paper. So before progressing with these comments, I do want to clarify my intent in writing you.

Although I do have an argument with you that concerns technical matters about boll weevil, my comments are in no way an indication of a distaste or of a personal feeling I hold toward either of you, any person with your agency or anybody else, for that matter. Because I have thoroughly enjoyed working with both of you and all other APHIS personnel involved in the High Plains program. Further, I am greatly indebted to you for your excellent cooperation during my stay at Lubbock, and especially in 1969 during the course of the large trapping experiment, in supplying me traps and in meeting all other requests I ever made. I have yet to work with a more cooperative or congenial group of people. So I hope my analysis herein of the reference paper will in no way be taken as a personal attack at you or anybody else.

I think your paper presents some highly worthwhile material from the standpoint of portraying the magnitude in logistics required to put together a large-scale trapping effort. Your description of the problems associated with the trap crops, sticky traps and live males should serve as extremely valuable advise for future entomologists who decide to implement a similar large-scale

program. Also, you present some very excellent data in support of your conclusion that only a very small percentage of a large number of traps in an area may actually contribute to a suppression effort.

However, I strongly question your conclusion concerning the primary objective of the experiment which was, as stated in the introduction, "... to determine whether the boll weevil wing trap would be effective for population suppression". My criticism is that your paper failed to acknowledge the fact that considerable information, in published as well as unpublished form, from the experimental area presents a good contradictory argument to your statement in the last sentence under Results: "The data indicate that the wing traps did a good job of reducing the number of emerging overwintered boll weevils to enter cotton fields and suppressing the boll weevil population in the early and middle part of the growing season". There appears to be a very good counteracting argument to this conclusion. But no citation was made of any of the documented material leading to that argument. And this could hardly have been due to oversight, since the published material was as accessible as other material that was cited. Rather, it appears to me that there was a strong attempt to oversell the trap as a suppression tool or, at least, there was no attempt to present both sides of the story regarding the hypothesis set forth in the experiment's objective.

Now, let me get down to specifics:

The results showed that only 190 (19.2%) of the 989 cotton fields in the trapping experiment area were infested with boll weevils during the month of August. From these results, it was concluded that the wing traps did a good job of reducing the number of overwintered boll weevils. And this reduction thereby lessened the degree of infestation that otherwise would have developed later in the season.

I fail to see anything significant about 19.2%. This percentage infestation record compares very favorably with what we frequently see in this area in late August of some years, with or without the traps, if there is a reasonable reproduction-diapause control effort during the previous year. And there is published information to this effect.

Admittedly, boll weevil populations may fluctuate considerably from year to year in this area. But you should be familiar with the previous documented material, both published and non-published, from this same area that reveals infestation trends nearly identical to those shown in the present paper. Some of this material has been published for several years now. And it has revealed that, during a year of overall low weevil density, whether or not a cotton field becomes infested (as determined by survey procedures comparable to those reported in the present paper) is primarily dependent on the location of the field in relation to the hibernation habitats. The enclosed paper (Rummel and Adkisson, 1970, Distribution of boll weevil-infested cotton fields in relation to overwintering habitats in the High and Rolling Plains of Texas, J. Econ. Entomol.) points this out very clearly.

If only 19.2% of the fields in the trapping area became infested in August, what percentage of those fields out of the trapping area became infested? And how does this ratio (i.e., % infested in trapping area: % infested out of trapping area) compare with the ratios obtained in other years when traps were not employed in either area? I think it might be helpful to check out available

information in this regard.

The article concluded that, from April 23 through July 23, wing traps captured 10,159 emerging overwintered boll weevils. It is further stated that the significance of capturing this many weevils is difficult to determine except from a hypothetical stand point. Then an example is cited to show that, assuming an average of 5-fold increase per generation, the capture of this many (i.e., 10,159) overwintered weevils theoretically would have eliminated 1,269,875 weevils through the third generation.

I am somewhat surprised that this 5-fold factor, obtained from studies in the Southeast, was assumed for this area. Because there is documented material, published as well as non-published, on boll weevil population dynamics in the immediate area. It appears that even from a hypothetical sense, it would have been more realistic to have used rate increase data from the area of discussion than from another area so far away and so ecologically different.

I am sure that you must be familiar with data from the Rolling Plains area, or from other areas, on the longevity of overwintered boll weevils upon emergence from hibernation. Based on what these data reveal, I strongly doubt that, even in the hypothetical sense, it is logical to assume that all of the 10,159 trapped weevils would have been expected to contribute to the population increase. That is, many of those weevils captured in April and May, for instance, would not have been expected to survive to infest squaring cotton (i.e., cotton with reproductive sites). There is information available from studies I conducted at Lubbock which would indicate a very low survival probability in those early emergers.

I found it somewhat strange that the authors of this paper did not bother to acknowledge much of the documented material which reports on research conducted in the High Plains-Rolling Plains area since 1964. Much of this material has been published in the Journal, some in the Annals and a lot more in Experiment Station bulletins. All of the unpublished material I obtained while in Lubbock was documented in annual reports, and you should have had access to these reports because I sent <u>all</u> of them to one or to both of you or Mr. Helms.

It is solely the prerogative of an author to cite or not to cite material related to his subject matter. So it is perfectly understandable that much of the related published work in this area was not cited, because it was not actually relevant to the present study. However, it does seem unusual that there was no attempt to acknowledge work which produced evidence in direct opposition to the conclusion presented within your paper.

This experiment, as near as I recall, cost the cotton industry and federal and state agencies $250,000-300,000, not including the many SMY'S of professional people who worked on the experiment. I don't doubt that the money was well spent. In fact, I think the knowledge gained in logistics requirements, in a large trapping effort was, in itself, worth this expenditure. And I don't think the sponsoring agencies have any qualms whatsoever as to how this money was spent. But I do think, and bet the sponsoring agencies would concur, that it is the responsibility of scientists involved in <u>any</u> experiment to present more than just the facts in support of an argument if facts to the contrary are also available. It appears to me that this was not done in the experiment described in your paper, and I did want to discuss this with you.

Under separate cover, I am sending both of you several publications and annual reports which contain all or some material related to the items discussed herein.

Again, I will state that this memorandum is not a personal attack toward anybody. I am totally responsible for all statements made, if somebody should interpret the memorandum differently. No person had prior knowledge of this memorandum, and I included Drs. Adkisson and Rummel as cc receivers merely because I cited a paper of theirs in reference to the work you reported.

Best regards.

cc: Dr. P. L. Adkisson
Dr. D. R. Rummel

encl.: 1

The National Audubon Society
1511 K Street, N.W. - Suite 831
Washington, D.C. 20006
September 30, 1975

Deputy Administrator
Plant Protection and Quarantine
Programs, Animal and Plant
Health Inspection Service
U.S. Department of Agriculture
Washington, D.C. 20250

Re: USDA-APHIS (ADM-75-1)
Trial Boll Weevil Eradication Program, Draft Environmental Statement
(40 Federal Register 32860-1
August 5, 1975)

Dear Sir:

The National Audubon Society hereby submits comments on the above referenced environmental statement.

I. DESCRIPTION - Federal Involvement with the Boll Weevil (pp. 1-33)

Federal involvement with the boll weevil has long emphasized chemical control. Resistance had already become a threat in the 1950's as research was geared toward developing alternative chemical control methods. Unfortunately, the effort has had as its goal methods of control "that might lead to eradication from all infested cotton-growing areas in the United States," and this concept has been adhered to ever since. (p. 13 DEIS) In 1968, the National Cotton Council formed a "Special Study Committee on Boll Weevil Eradication" to consider actions to be taken if and when research advanced to the stage that boll weevil eradication might be technically and operationally feasible and practical. As early as May 6, 1969, this committee concluded that supression techniques "may have already been developed to the extent that eradication could be achieved when applied in an integrated program." (p. 13 DEIS) This theory was tried out in the 1971-3 Mississippi pilot projects.

The results of this experiment are still in dispute. Appendix C (p. 177) contains the Statement by the Technical

Guidance Committee which conducted and guided the pilot project. That Committee concluded that "...it is technically and operationally feasible to eliminate the boll weevil as an economic pest in the United States by the use of techniques that are ecologically acceptable. The recommendations, however, point out four areas in need of intensified research to further improve the technology and operational procedures for certain suppression components necessary to maximize efficiency and economy in the elimination of the boll weevil.

The four areas are: (1) improve mass rearing procedures for ensuring high quality sterilized weevils, (2) improve sterilization techniques to assure vigor and mating behavior of males, (3) develop new methods of sterilizing both sexes, and (4) research on grandlure.

In contrast, the Report (on the Mississippi Project) of the Entomological Society of America Review Committee (Appendix D, pp. 179-82) was divided as to whether or not technical feasibility of eradication of boll weevil populations has been demonstrated. The Committee unanimously expressed reservations concerning any massive eradication undertaking "<u>without further research to refine suppressive techniques</u>." The Committee added, "We are also cognizant of the very complex operational difficulties that must be overcome if and when a more extensive boll weevil eradication effort is undertaken." (181 DEIS)

The reasons for the reservations are as follows:

> " Although important technical and operational improvements were made and incorporated into the experiment as it progressed, much additional research in certain areas is essential to pursue the original program objectives. We believe the following to be the more significant limiting factors in the experiment, and they need to be researched <u>prior to planning and implementing any future population suppression programs</u>: (emphasis added)

" 1. Improvements in the mass production procedures. Contamination of weevil stock with disease organisms, and other technical and operational problems prevented adequate production of high quality weevils needed for the sterile insect release program.

" 2. Improved sterilization procedures. If possible, the sterilization method should be effective for both sexes, in order to circumvent the costly step of sexing weevils prior to release, and to avoid the accidental release of fertile or only partially sterile females.

" 3. Improved surveillance techniques. Although pheromone baited traps, and particularly the model

developed late in the experiment, give promise of being highly effective for population surveillance, continued research on the pheromone 'grandlure' is strongly indicated. Further emphasis on grandlure as a population regulation tool is indicated. The mechanical population sampler is also a useful monitoring tool. But reliable data to indicate the population level that can be detected by these methods is lacking and therefore the only alternative appears to be the continuation of the monitoring program, as well as suppressive measures, over a considerable period of time to assure that eradication has indeed been accomplished.

"4. Determine the relative value of suppressive components. Some research should be dedicated to an attempt to quantify the relative value of each component in the series of suppression techniques in different regions. Following research designed to further improve suppressive techniques, it may be possible to simplify the overall effort by restructuring the program and perhaps even to delete one or more components. For example, if improvements in certain techniques (e.g. pheromones) prove sufficient to accomplish desired goals, the expensive, problem-ridden sterile insect release system may be unnecessary. . .

"Large scale field trials of any kind usually bring to light a multitude of unanticipated operational problems, and the pilot boll weevil eradication experiment was no exception. The periodic progress reports are replete with accounts of operational problems, small and large, that had to be solved. These involved such diverse matters as design and development of a trash sampling machine, design and production of practical boll weevil pheromone traps, swath width for aerial treatment of cotton with insecticides, coordination of agronomic practices, standardization of field inspection procedures, and methods of sterile weevil release. During the 1971 season, it became evident that growers in the first buffer zone, who were initially expected to conduct the in-season insecticide application program, did not have the proper equipment to do the job. Consequently, in 1972 and 1973, it became necessary for the program's operational personnel to take over that task, thus further taxing the already strained financial support of the program. One of the most disturbing developments, indicative of the kind of operational problem that could effectively negate a

large-scale eradication effort, was the failure to detect one cotton field in the core zone until near the end of the second growing season.

"In the opinion of this Committee, the major difficulties that will attend any massive effort against the boll weevil are likely to be less those of a technical nature than of the operational aspects - particularly 'people problems' involved in implementing and carrying out the strategies and tactics chosen for suppression of boll weevil populations. Further, any large-scale pest suppression or eradication undertaking inevitably brings about an interplay of very diverse social, political and economic interests, and reactions to a proposed boll weevil eradication effort will not be limited to the cotton producing areas. The cooperation of cotton growers and participation of the appropriate government agencies in such a program will not alone be sufficient, even assuming adequate financing which is essential for a venture of this kind.

"This Committee does not presume to know whether or not a Belt-Wide boll weevil eradication effort should be undertaken. However, we have reservations until such time as currently available suppressive techniques are improved and collectively tested in different geographical and/or ecological areas.... We believe <u>the decision regarding attempted eradication should and will</u> be a <u>socio-political decision</u>. Accordingly, we recommend that a <u>detailed</u> summary of this program be published and that all concerned persons and especially all entomologists, inform themselves as to the long range environmental and economic benefits that would result from a successful eradication program and weigh those against the costs involved. If pest management is to play its proper role in resource management, decisions as to programs to be undertaken must be made objectively and realistically and those programs implemented must be prosecuted vigorously and decisively." (emphasis added)

National Audubon agrees with the Entomological Society Committee that research needs to be completed <u>before planning and implementing any population suppression program</u>. We insist that these problems be resolved <u>before</u> any comprehensive eradication program is even considered, let alone proposed.

II <u>ENVIRONMENTAL IMPACTS</u> (pp. 33-36)

The environmental impact section is one of the most deficient parts of an exceedingly inadequate DEIS.

We take exception to the statement at page 33, "Pesticides will be applied only to cottonfields." We wish to point out

that during the DDT administrative hearings, the question was raised on how much pesticide stays in the field to which it is applied. Dale Newsom replied that he did not know. Dr. Newsom was then asked, "Do you know in your own area how it is kept out of wildlife habitats which may be on the edge of the cotton fields?" The answer was:

> "There is discretion used and practised, at least, with many of our aerial applications on it in attempting to prevent drift by taking advantage of wind directions and direction of flight path to avoid contamination of wildlife areas. But this is not possible to do it all, to prevent all of this under our situation. It is simply impossible."1/

And later, when questioned by Agriculture's counsel, "Are there large numbers of such habitats to your knowledge adjacent to or contiguous to cotton fields?" Dr. Newsom responded, "Yes, there are areas adjacent to cotton fields that do form good wildlife habitat."2/

The statement is made at page 34, "Therefore, significant damage to wildlife and other non-target organisms is not expected." "Evidence" to support this contention is found in section III at pages 38-42. We seriously question the effect of massive uses of the proposed insecticides on non-target organisms, if implemented in an all-out eradication program, particularly with Guthion which is a very toxic poison.

The most serious problem with such massive doses of pesticides, however, is the resistance factor. Dale Newsom pointed out that "the heavier the pressure put on a species the more likely you are to bring out inherent resistance."3/ The proposed program would douse large areas of the U.S. with a concentrated quantity of insecticides. This is the quickest way to induce resistance in insect populations. By using repeated, heavy doses, only those weevils with an inherent mechanism to survive, such as an enzymatic detoxification system, would be left to reproduce. Normally, resistant and nonresistant populations mix together with the effect of slowing the spread of resistance. The

---

1/ DDT Transcripts at 2385

2/ DDT Hearings, Transcript 2412

3/ Carter, Luther, "Eradicating the Boll Weevil: Would it be a No Win War," Science, 183-499, Feb. 8, 1974.

massive use of insecticides over large areas could hardly be better designed to spread resistance quickly, should the species possess the capability in its gene pool. This not only would doom the project to failure, it could produce a super boll weevil.

National Audubon suggests that both non-target effect and induced rapid resistance are probable adverse environmental effects which could not be avoided if the proposed action proceeds.

III. SUMMARY OF PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

(See comments under II above.)

IV. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY (pp. 42-47)

This section is also woefully inadequate. The DEIS only compares the economic analysis of an eradication program versus the current control program. No attempt is made to estimate, or analyze, benefits, economic or otherwise, from alternative boll weevil control programs. The DEIS tries to protect itself by the statement on page 45, "This approach has never been executed on a large contiguous area and these estimates may prove to be overly optimistic insofar as benefits and costs are concerned."

We have four points to make in regard to this section:

(1) Dr. Brazell at the Feb. 14, 1975 APHIS meeting with environmental groups, stated that should the goal of total eradication fail, the experiment would "render many benefits." He then declined to elaborate. We submit that the above analysis is predicated on the assumption that eradication would succeed. If it fails, as many observers believe, it not only is an expensive boondoggle for the federal government, it will cause many severe problems.

(2) The massive effort eradication would involve constitutes a great federal, state and private expense, with a minimal cost to cotton producers. This program therefore is a form of subsidy to the producers, who not only stand to gain from this federal expenditure, they are simultaneously pressuring to impose a cotton export control.

(3) The millions (if not billions) of dollars the eradication program would cost should be going to research into developing

varieties of cotton, resistant to the boll weevil,*/ and refining the integrated pest management program. From the long range view, this is the only alternative that will help the ailing collon industry.

(4) At page 45 the statement is made that consensus among boll weevil experts is that control with existing insecticides (organophosphates) will be lost in from 5-10 years. This is based on Dr. Knipling's belief that eradication must be undertaken before resistance sets in, even though the process of eradication may in itself hasten the resistance process.

---

*/ Dale Newsom (Science Magazine, op. cit., p. 499) stated that in his view, the USDA and the cotton industry should be giving greater emphasis to the development of varieties of cotton that are resistant to the boll weevil.

Also, C. S. Lewis, a cotton geneticist, on the USDA's national program staff in Beltsville is currently conducting research on cotton varieties.

V. IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES (P. 47)

The statement that eradication of the boll weevil should tend to restore the original ecological balance between other cotton pests and their natural enemies is preposterous. That massive use of insecticides could restore any natural balance is outrageous.

VI. ALTERNATIVES TO THE PROPOSED ACTION (pp. 47049)

APHIS concludes that from the available alternatives, "Obviously, the proposed trial eradication program is the best choice available. There is every reason to believe that success will be achieved, thus proving that boll weevil eradication is possible." It seems the decision has already been made by APHIS.

Aside from this prejudgment, we wish to point out alternatives APHIS has neglected to consider. They are as follows:

A. Cotton-Pest Management System

Other management strategies have been developing which should be considered in an environmental impact statement. One significant strategy is the Cotton Pest Management System which was funded by the National Science Foundation and EPA in cooperation with ARS-USDA. The experiment was conducted by the Texas Department of Corrections (TDC) and the Texas Agricultural Experiment Station. In summary, the strategy was: 1) to control the boll weevil with a fall diapause program; 2) to control the cotton fleahopper with low dosages of insecticides applied during the early fruiting phase; 3) to terminate fleahopper treatments in early season to allow beneficial insects and spiders to increase in numbers so that they can help regulate bollworm-budworm; 4) to increase the treatment level for bollworm-budworm so that beneficial insects and spiders have a chance to control them before insecticides are applied; and 5) to harvest the crop and destroy crop residues as early as possible. */

The results indicated that insecticide use declined by half (from 12.9 lbs per acre to 6.4) while increasing yield

*/ Economic and Environmental Implications of Cotton Production Under a New Cotton Pest Management System, The Texas A&M University System, J.E. Miller, Director, MP-1152, June 1974

from 229 to 345 lbs of lint on the Brazos River TDC farms. The Trinity River TDC farms also used 50% less insecticides (from 10.8 to 5.6 lbs) and increased yield about 80 lbs of lint with a net revenue increase of $35 per acre.

B. Cultural or Environmental Manipulation

1. Resistant cotton varieties

2. Alterations in plant spacing to influence insect populations by changing their microhabitat and the density of their food supply.

3. Revise economic thresholds and control strategies.

4. Crop rotations (sequence of crops planted in a field.

5. Changes in planting time

6. Land preparation and cultivation

7. Fallows (idle periods in field use)

8. Planting cotton over as short a time period as possible to allow simultaneous maturation. (This limits the number of generations)

9. Diversification of crops lessens the number of any particular insect species by limiting the availability of a single good source of food.

10. Strip cutting to preserve a stable habitat for natural enemies in the unharvested portion of the field.

C. Biological Controls

Has APHIS considered release of predators and parasites? The Brownsville, Texas Agricultural Research Service is conducting research on programmed releases of entomophagous insects and manipulation of natural populations. Dr. Graham, of the Brownsville Station, reports the development of usable baits for *Heliothis* larvae as a major step toward improving the outlook for pathogens (*B.t.*, *Heliothis* and *Autographa* NPV's). He feels research should be stepped up on developing other toxin-producing bacteria as insecticides, as well as improved strains of and fermentation methods for *B.t.*,

VII. CONSULTATION WITH APPROPRIATE FEDERAL AGENCIES AND REVIEW BY STATE AND LOCAL AGENCIES. . .

National Audubon asks why the Department of Interior was not automatically consulted on this statement?

GENERAL COMMENTS

To initiate an eradication program now would mean the end of the integrated pest management program for cotton. at a time when it is only getting started. In fact, the eradication program misuses the integrated pest management goals in the guise of "management control."

In 1972, in reporting on the Mississippi project, Dr. Brazell stated, "the committee feels that one of the most important contributions which can be made at this time is to furnish the necessary information on pest populations to the farmer to allow him to make decisions on whether or not to apply pesticides on the basis of actual need. The basic objective of a pest management program will be to limit the use of pesticides to situations in which they are needed to prevent economic damage to a crop. This will not only result in savings in cost of production, but will also reduce the overall amount of pesticides being added to the environment." This statement would support the work of the Cotton Pest Management System described under VI.A. above.

The commitment of integrated pest management was a directive by the President to Congress on February 8, 1972. That directive stated that new technology of integrated pest management must be developed so that agricultural and forest productivity can be maintained together with, rather than at the expense of environmental quality. Integrated pest management means judicious use of selective chemical pesticides in combination with non-chemical agents and methods. It seeks to maximize reliance on such natural pest population control as predators, sterilization, and pest diseases. That directive required the Department of Agriculture, the National Science Foundation, and the EPA to launch a large scale integrated pest management research and development program. This program is still in the developmental stage.

The Mississippi project illustrated the complexity of the problems that need to be met before eradication could be pursued. Unfortunately, the rationale for the program rests

not with resolution of the difficulties evident in the Mississippi project, but on the presumption that eradication must proceed before resistance sets in, and the problem is where to start to eliminate the boll weevil from the United States. We must conclude that the proponents of eradication are so persuaded of the eradication concept that they are determined to go ahead with the project, knowing that once launched, the program can go forward, inherently flawed, but assured of a long future, since to begin is never to end. As Dale Newsom said, if the program falters, proponents will explain away the problems and ask for more funds. */ The Mississippi project was to have been a demonstration project. We do not need yet another project to demonstrate the same problems. A great deal of energy and manpower has been spent on the eradication program. It is time meaningful projects are developed and encouraged.

Respectfully submitted,

Maureen Hinkle

Maureen Hinkle
Pesticides Monitor
National Audubon Society
1511 K Street, N.W. #831
Washington, D.C. 20006
(483-3265)

cc: EPA
CEQ
DOI

*/ Environment Magazine, Vol. 16, No. 5, p. 10,

Public Citizen

September 26, 1975

F.J. Mulhern
Deputy Administrator
Plant Protection and Quarantine
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
Washington, D.C. 20250

Dear Mr. Mulhern:

Enclosed are our comments on the Draft Environmental Impact Statement for the Boll Weevil Eradication program which you requested.

Yours truly,

Stephanie Harris

Stephanie Harris
Staff Associate

HEALTH RESEARCH GROUP • 2000 P STREET, N.W., WASHINGTON, D.C. 20036 • (202) 872-0320

COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE TRIAL BOLL WEEVIL ERADICATION PROGRAM

The Health Research Group strongly opposes the trial boll weevil eradication program. The draft environmental impact statement (DEIS) is inadequate and does not meet the requirements of section 102 of the National Environmental Policy Act in that a comprehensive discussion of available alternatives is lacking. Furthermore, very little detail is presented indicating what measures (if any) will be employed to protect man and the environment from the adverse effects of the pesticides to be used. Finally, the cost-benefit analysis is based on false assumptions thereby leading to erroneous conclusions.

I. Philosophical Disagreements

The Health Research Group differs in principle with the U.S. Department of Agriculture (USDA) on the philosophical tenets which form the groundwork of the eradication program. The following are our concerns:

1. Feasibility and Desirability of Eradication

There is little evidence that eradication of any major pest has ever been achieved for a long period of time. The screwworm eradication program in the Southwest U.S. is often used as an example of the successful elimination of a pest from the U.S. Yet, as pointed out by L.D. Newsom* there were 4,236 cases of infestation in May, 1972, as compared to 6,372 during May, 1962. This hardly seems like

---

* "Pest Management: History, Current Status, and Future Progress", to be published.

an effective eradication program. One of the major problems with screwworm eradication has been reinfestation from Mexico. The USDA is currently trying to control this by release of sterile screwworms in Mexico as well as in the Southwest. The screwworm case is a good analogy to the boll weevil as a reinfestation of boll weevils from Mexico is feared and yet the USDA presents no plans in the DEIS to prevent this occurrence.

The conclusion of the USDA that eradication of the boll weevil is feasible is based upon a trial program which lasted three years. During this trial run a major problem arose when a small plot of cotton remained undiscovered and thereby bred weevils which migrated to the "eradicated" zones. There was also migration from buffer zones into the test area. Because of the enormity of the proposed project (i.e. eradicating weevils from three states and eventually from the entire cotton-growing South) it is to be expected that small plots will be missed, as happened during the trial. Furthermore, as the eradication program will not be put into effect in the entire South at one time, it is to be expected that there will be migration from untreated areas into the treated zones. For these reasons total elimination of the boll weevil seems unlikely.

The concept of eradication of an insect pest is inimicable to an integrated pest management program. The proposed program will saturate the area with pesticides (18 treatments per year of organophosphates, 5 treatments of defoliants) which will upset the natural balance of insects. The DEIS admits that during such treatment the population of the beneficial insects (i.e. parasites and predators) will diminish

significantly thereby causing the loss of any biological control of the boll weevil which might have been present. Also, such heavy application of a pesticide will put undue biological pressure on the boll weevil and could easily cause a resistance to develop more rapidly. Once this occurs, there is no hope for success of the program as it is based almost entirely on the ability of the chemical pesticides to reduce weevil levels. The DEIS states that entomologists expect to see resistance to organophosphates within five years for the boll weevil. Even if this is not hastened by the overabundant application of pesticides during the trial program, if this program is deemed sucessful and extended to the rest of the South after the three year trial period by that time there may already be a serious resistance problem to cope with and the results of the trial will not be comparable to the situation three years hence.

Even though the USDA calls its program an integrated pest management approach due to the inclusion of cultural, biological, and autocidal techniques, this is a misnomer. An integrated pest management program has as its goal <u>management</u> and not <u>eradication</u>. It accomplishes this goal by establishing a stable balance in the ecosystem so that lasting control results. An eradication program, on the other hand, disrupts this balance so that control is maintained for a short period of time. Only when more external pressures are exerted can the unstable ecosystem be maintained. In a management program it is expected that there will be a low population level of the pest (below economically damaging levels) in equilibrium with their natural controls. Indeed, if there is no prey there would be no predators. Thus, by eradicating the boll weevil one cannot expect

to find the predators and parasites which are specific for that species.

An integrated pest management program utilizes chemical pesticides which are specific to the target pest so that the beneficial insect population is maintained. These chemicals are applied very sparingly so as not to disturb the ecosystem. The USDA program will do exactly the opposite by saturating the area with wide-spectrum pesticides which will adversely affect the beneficial insect population. These chemicals will not be used sparingly but will be applied on a schedule, thus repeating all of the bad practices of farmers which have led to eventual pest resistance to insecticides.

Finally, the use of pheromones and sterile boll weevils will be almost a gratuity in that they will be used once the boll weevil is almost eliminated (i.e. 2 boll weevils per acre). An integrated pest management program would depend on these techniques as well as others (cultural controls, resistant cotton varieties, use of pathogens against secondary pests) and use chemical controls as a minor part of the program.

Therefore, it is extremely misleading for the USDA to call the eradication program an integrated pest management program, especially as terming it as such is likely to win friends in Congress and with the public. We reiterate that the eradication is conceptually <u>diametrically opposed</u> to integrated pest management. While we favor the latter, we are opposed to the former believing that it will not work, will cost the taxpayers enormous sums of money year after year, and will be extremely detrimental to the health and safety of man and the environment.

2. Violation of Civil Rights

The DEIS emphasizes that in order for an eradication program to be successful there will have to be 100% participation of the growers. This can be accomplished only by following the totalitarian assumption of authority by state and federal governments, as outlined in the DEIS. Already there has been considerable opposition to the program within the land grant colleges, although now we are told that all of the colleges support the program (what type of economic coercion caused this reversal?). The DEIS also predicts that with a pest management program there would be grower apathy due to the low levels of pests and therefore only 85% participation can be expected (page 43). This lack of support is only the tip of the iceberg when considering the millions of people who will be affected by the saturation spraying of pesticides for the program. Pesticide application on this large a scale cannot be contained due to drift, land runoff, accidents and mistakes, and usual sloppiness of application. It is naive to believe that 100% of the population of the South is going to endorse this program.

Therefore, the government will have to assume the authority to tell growers that either they grow cotton according to the USDA rules or they grow another crop. It will also have to leave the average citizen without any voice to oppose the pesticide contamination of his/her home and general environment. Thus, in order to gain the required 100% participation in the eradication program, the USDA and state departments of agriculture will have to assume totalitarian control over this sector of agriculture and deprive farmers and others of fundamental civil rights. Needless to say, the Health Research

Group cannot condone this nor the implicit attitude of the USDA that "the ends justify the means".

II. Substantive Critique of the DEIS

1. Alternatives and Their Costs

Section 102 of the National Environmental Policy Act requires that an EIS include a discussion of alternatives. This DEIS devotes only one page to such a discussion which we find highly inadequate. In fact, in the cost comparisons between the proposed program and other approaches two alternatives are given: no control, and a pest management program. Neither of these alternatives are discussed in any detail (pp. 47-48).

In the pre-pesticide days of cotton-growing, farmers depended upon early planting and early harvest in order to beat the bugs. This method is describd by W.D. Pierce.* Such simple techniques provided the basis of a pest management system which allowed farmers to raise cotton profitably for three decades. In an economic sense, this approach could be classified as "no control" as there is no expenditure for control methods. Considering the enormity of the costs involved in the control programs which are discusssed (from $5 million to $69 million) it would seem that a no control program would have a very favorable cost-benefit ratio.

If additional control methods are added to the basic Pierce system in order to construct an integrated pest management program, the cost

---

* "How Insects Affect the Cotton Plant And Means Of Combatting Them", USDA Farm Bul. 890, 1922.

would necessarily increase, but it would remain considerably less than that for the proposed eradication program. For instance, the use of resistant, fast-fruiting strains of cotton (e.g. Frego bract cotton), destruction of crop residues, use of trap crops, importation of parasites and predators, use of scouts to detect economically damaging levels of boll weevils which have to be treated with chemical insecticides, use of pheromones, and control of secondary pests by the use of pathogens, would create an IPM program which would still be less costly than eradication. The two most expensive parts of the eradication program are the use of chemical pesticides (for which the cost increases continuously) and the use of sterilized boll weevils. By eliminating these two steps from the proposed program the cost would be diminished.

An argument made by the USDA throughout the DEIS is that eradication is feasible and therefore the costs incurred during the program will be the last outlay of funds for the control of the boll weevil, whereas other programs will have their costs repeated annually. We do not agree with this assessment because we do not believe that the eradication program will be 100% successful (particularly if no measures are taken to prevent migration of weevils from Mexico and other infested areas). Therefore, additional funds will have to be spent. Furthermore, a successful IPM program would establish a balance of beneficial insects and pests such that a natural and lasting control would be achieved. Thus, initial costs would not have to be repeated annually.

Without really discussing what is meant by a "pest management program" the USDA launches into a cost comparison of this and the

the eradication program which is very misleading.

The first assumption which is made is that only 85% of the acreage will be included in the program because of grower apathy; therefore, the average existing cost of control is used for the remaining 15% of the acreage to calculate the total cost. This assumption is unjustified. If there is to be 100% participation in the eradication program why should there be different exercise of authority for the pest management program? Thus, in recalculating the costs, we have assumed that there would be 100% participation (or one could assume 85% participation in the eradication program). Furthermore, $148,050 was included for research and development costs. This is research which has been on-going and will continue to be done regardless of what program is adopted; hence, to include this as a specific cost of the pest management program is unjustified.

Consequently, in recalculating the cost for the pest management program we have used 483,848 as the total number of acres involved, to receive 4 applications at $1.50 per application and to cost $2.50 per acre for regulation and scouting. The total cost of the pest management program would be $5,322,328 (as opposed to $5,855,994 as stated in the DEIS). In comparing this figure to the other program costs ($13,441,915 for the existing boll weevil control and $69,920,874 for the eradication program) it becomes obvious that the pest management program is by far the most economical (costing 38% of the existing control program and 7% of the eradication program). It seems very curious that the DEIS should give it such cursory treatment as to not even discuss the components of such a program!

In comparing the costs and benefits of the eradication program, various standards of comparison are used to make the program seem more favorable. Where the effect on wildlife was considered, bee kills in the eradication program were compared to a "normal" program (p. 38) where chlorinated hydrocarbons (rather than organophosphates) are used. However, the benefits are calculated as a difference in the value of the crop produced under the eradication program as compared to the value of cotton produced using "no chemical controls" (p. 43). In other words, the worst standard of comparison is used in both instances: environmental costs are compared to present systems of production which depend upon a lot of very toxic chemicals while the benefits are compared to a system which uses no chemicals (or other controls) and thus has a low productivity. If alternatives were adequately discussed, an IPM system would be outlined and costs and benefits of the eradication program would be compared to this as a legitimate way of deciding which program is more beneficial in the long run.

Also, it was assumed that the value of cotton production under a pest management program would be half the existing yield losses with present controls (p. 43). This is a totally unjustified assumption and is not supported by any evidence in the DEIS.

2. Environmental and Health Effects

Inadequate data are presented to truly assess the environmental and health effects of the eradication program. As has already been discussed above, the bee kills are discussed, as are the detrimental effects of the pesticides on beneficial insects. There is no doubt that these insect populations will decrease and we question the USDA's

prediction that they will reappear after the first few years of the program during which time the heaviest spraying has taken place. (For instance, even if the insects return, if true eradication results, what will the parasites and predators of the the boll weevil feed on?)

The effect of malathion and guthion on terrestial and aquatic wildlife is deduced from a program in Michigan and Nebraska which used these chemicals at a lower dose rate (0.64 lb./acre as compared to 1.25 lb./acre (p. 39)). Obviously, these two programs are not strictly comparable. Conclusions from tests on malathion and guthion on quail and birdlife fail to state the level of application (p. 39), so that one cannot determine whether these field tests are relevant. No field studies on chlordimform (sic), Def, or Folex were performed on aquatic species (p. 41). No consideration of potentiation of these various chemicals is given, even though malathion is known to potentiate other organophosphates.

Human health effects are not considered at all. The USDA states that "protective measures" will be taken to protect man and animals (p. 34) but what these measures will be is anybody's guess! Certainly, use of chemicals on such a vast land area will be especially difficult to control and it is to be expected that the pesticide residues will travel through drift and from land run-off. The applicators will be exposed as will residents of the area. Even though "trained personnel and highly trained supervisors" will apply the pesticides (p. 33), one would expect a certain degree of human error, sloppiness, and accidents. The DEIS should include information on just what type of training is to be given to these applicators.

While guthion is about 100 times more toxic than malathion, having an LD_{50} of 16.4 mg/kg as compared to 1650 mg/kg*, still malathion has been known to cause severe allergenic reactions in sensitive people. Furthermore, guthion is a suspect teratogen, reducing litter size and causing embryotoxicity in mice.** This information and other data on chlordimeform, Def, and Folex should have been presented in the DEIS.

Conclusion

The DEIS is very incomplete with regard to a discussion of available alternatives and the health effects of the pesticides to be used. The eradication program is by no means an integrated pest management program and it should not masquerade as such. The proposed program is environmentally destructive, detrimental to human health, and probably will not succeed in eradicating the boll weevil. To continue with this program would be a waste of enormous sums of taxpayers' money and we urge the USDA to reconsider its position.

---

* Lehman, A.J., Summaries of Pesticide Toxicity, Kansas: Assoc. of Food and Drug Officials of the U.S., 1965.

** Report of the Secretary's Commission on Pesticides and Their Relationship to Environmental Health, 1969, p. 665.

TEXAS A&M UNIVERSITY
COLLEGE OF AGRICULTURE
DEPARTMENT OF ENTOMOLOGY
COLLEGE STATION, TEXAS 77843

Instruction-Research-Extension Phone 845-2516

September 30, 1975

Deputy Administrator
Plant Protection and Quarantine Program
APHIS-USDA, Room 302-E, Adm. Bldg.
14th and Independence
Washington, D. C.

Dear Sir:

I recently received a copy of the Draft Environmental statement for the Trial Boll Weevil Eradication Program. Attached are some comments I wish to make concerning several specific items in the proposal.

My background is that of an entomologist-toxicologist with extensive experience working with insect resistance to insecticides and with the toxicity of insecticide: synergist combinations. For your information a copy of my vitae is enclosed.

The main point I wish to stress is that several of the chemicals that are proposed for use in the program present serious possible human health hazards when used as combinations. In the absence of good mammalian toxicology data on the toxicity of these combinations, I urge extreme caution be followed in using any of these materials as mixtures.

Some specific comments are attached.

Sincerely,

F W Plapp Jr.

Frederick W. Plapp, Jr.
Professor

FWP/ar
enclosures:

References

1. Plapp, Frederick W. and Gaines W. Eddy, 1961, Synergism of Malathion Against Resistant Insects, Science 134, 2043-2044.

2. Plapp, Frederick W, 1975, Chlordimeform as a Synergist for Insecticides Against Larvae of the Tobacco Budworm, Tech. Rpt. No. 75-25, TAES, College Station, Tx.

1. P-23. The statement is made that chlordimeform in combination with azinphosmethyl or malathion will be used to prevent buildup of Heliothis populations. USDA should be advised that in work done here we have recently determined that combinations of chlordimeform with many organophosphates are synergistic in toxicity to H. virescens. Specifically, the toxicity of malathion:chlordimeform in mixture was 5.2 times greater than that of malathion only. This is fine for insect control, but should be evaluated in terms of mammalian hazard before use of combinations on a widescale basis is undertaken. A copy of a preliminary publication describing chlordimeform synergism of insecticides against Heliothis is enclosed.

2. P-24. The organophosphate defoliants Def and Folex have previously been demonstrated to be strong synergists for malathion against insects (F. W. Plapp and G. W. Eddy, Science 134: 2043, 1961, copy enclosed) and against mammals (J. E. Casida et al., Biochem. Pharmacol. 12: 73, 1963). The use of the defoliants in combinations with the insecticides could pose a serious health problem to pesticide applicators working in the program. I recommend that care be taken to insure that insecticide:defoliant combination sprays not be used in this program due to the possible human health hazards involved.

3. P-45. As an expert on insecticide resistance, I cannot agree with the statement that "boll weevil experts" think existing insecticides will only be effective for 5 to 10 more years. Past experience has indicated that boll weevils possess the ability to become resistant to organophosphate insecticides. On the other hand, intensive use of insecticides such as would be practiced in an eradication campaign might very well speed the development of resistance. If this is so, the "no chemical" baseline for estimating benefits (Table 6) may not be valid.

UNITED STATES DEPARTMENT OF AGRICULTURE
EXTENSION SERVICE
WASHINGTON, D.C. 20250

Cooperating with Land Grant Colleges and Universities

September 15, 1975

SUBJECT: Draft Environmental Statement for the Trial Boll Weevil Eradication Program

TO: F. J. Mulhern, Administrator
APHIS

This is an excellent report; however, we do have a number of suggestions which should improve the final statement. Our comments on the Draft Environmental Statement for the Trial Boll Weevil Eradication Program are as follows.

We note that nothing is mentioned of the $350,000 provided by Congress in FY 1975 for cotton insect pest management in 11 boll weevil infested states, nor is the FY 1976, $1.2 million for management of boll weevil and other major cotton pests mentioned. This will be a significant and continuing contribution that will benefit cotton producers.

A cost-benefit study is always difficult. However, a revision of the relative cost and benefits for alternative courses of action for boll weevil control might be worthy of consideration. Was a cost-benefit study on the Mississippi eradication experiment done? Data from a cost-benefit study of the Mississippi eradication experiment would be most helpful in developing a cost-benefit study for the larger trial in North Carolina or for a beltwide eradication program. The present cost-benefit study has a very serious deficiency. In comparing the costs and benefits from the eradication program with a pest management type program, it is assumed that a general cotton insect pest management program would not be required after eradication of the boll weevil. This certainly is not the case because many of the cotton insects that cohabit cotton fields with the boll weevil are serious cotton pests in areas where the boll weevil does not exist. Most entomologists agree that after eradication a pest management program would be required and that the cost would be somewhat similar to the present pest management program that includes boll weevil. Therefore, the cost of eradication with the necessary followup pest management program would be much greater than indicated; and, of course, the benefit-ratio of an eradication program would be reduced after eradication. A general insect pest management program would be required on at least 50 percent of the boll weevil infested acreage in the United States. In some areas the acreage requiring pest management would be essentially the same before and after eradication. This does not mean that boll weevil eradication is not a desirable goal or that many insect problems would not be lessened if chemicals were not used to control weevils.

One problem that must be addressed is the economic status and possible participation of private consultants in an eradication program. This would not be a major consideration in the proposed trial area but would be a serious problem if eradication were extended to states such as Mississippi, Louisiana, Arkansas, and Texas where many private consultants offer these services to farmers. During the operational phase of the eradication program, which would probably last three years, the services of the private consultants would be unnecessary to farmers and would result in unemployment and economic losses for the private consultant because most insect problems would be handled by the Federal program. Private consultant services would be required for managing other insects after eradication but the consultants would lose customers for three years. In developing pest management programs, the USDA has been careful that state and federal programs do not interfere with private enterprise.

The following comments refer to specific pages in the environmental statement.

Page i, No. 2 -- the last sentence more accurately should read, "control of insects for boll weevil control." The previous statements infer that insecticides for boll weevil exceed all other pest control costs. This is not so when control of weeds and plant diseases are considered. They also are considered pests by most people today.

Page i -- The first line of the last paragraph should more appropriately read, "the population eradication technology that will be utilized in the...." Suppression usually indicates something short of eradication.

Page ii, No. 4 -- this sentence should read, "alternatives considered to the proposed programs are: (1) organizing and implementing an areawide general insect management program which would include boll weevils." A pest management program for only boll weevils is impractical and would not be economically justifiable in many areas.

Page 8, first paragraph -- it should be mentioned that some of these secondary pests are also serious pests in other cotton areas where boll weevils are absent.

Page 9 -- it should be mentioned that the boll weevil has not moved into many western areas even prior to initiation of the 1964 containment program in Texas. An explanation should be given for this phenomenon.

Page 14 -- the figures reflecting the cost of the Mississippi eradication experiment do not show inputs from the Cooperative Extension Service. It is our understanding that $52,000 of the monies indicated from Cotton Inc. were for Extension activities. Also, the Mississppi Cooperative

Extension Service provided in-house funds to support this program. These figures could be obtained from Mississippi Extension.

Page 20 and 21 -- where the overall program strategy is described, it should be pointed out that the pre-program practices will largely be carried out by the Cooperative Extension Service. During the three years of the eradication operation, no indication is given that the regulatory phase will be supported by the Cooperative Extension Service to provide general education and information. This should be added to the list of program contributions for each year of the eradication program.

Page 22, second paragraph -- states that "in-season insecticide treatments will be made in compliance with recommendations of the state research and Extension agencies." It will be helpful in an environmental statement to indicate which insects will be considered in this regard.

Page 23, first paragraph -- what type of insecticides will be applied for treatment of incipient infestations in the second and third year of the program? No mention was made of the necessity for surveillance and maintenance following the main eradication thrust.

Page 25, second paragraph -- states that "trap crops, consisting of selected areas of farmer cotton near the field borders and adjacent to boll weevil hibernation sites will be maintained in <u>every</u> cotton field." This needs some clarification. Do trap crops refer to early planted trap crops? Nothing is mentioned of bait stations or other techniques as an alternative to early planting of trap crops. Depending on the year, it is not thought possible to use trap crops, which are a key component of the eradication system, in some areas of the United States. This is because of time of planning and potential for early frost, or because wet cold springs often cause severe stand losses from seedling diseases. Also, any delay in planting of the main crop will create late season insect problems. An indication should be given as to what will be done to assure success of the program in situations where trap crops cannot be planted.

Page 43, last paragraph and at several points in subsequent pages and tables -- the cost of a pest management program is described as amounting to $1.50 per acre and <u>regulatory</u> measures at $1 per acre. In fact, such a pest management program probably will not and does not significantly involve regulatory measures. Therefore, we suggest deleting "regulatory"

and substituting "technical support" measures at $1 per acre. We also feel that $1 per acre will be much higher than required for technical support by Extension of such a program for cotton. We now know that the technical support costs of a cotton insect pest management program can be reduced to about 25¢ per acre; grower costs for scouting and supervision may be $1.25-1.75 per acre.

Page 43, last paragraph -- the statement indicates that in a pest management program, 15 percent of the acreage would not be included in a voluntary program. This is correct, but usually this 15 percent of the acreage does not sustain sufficient economic damage from boll weevils and other insects to justify growers' financial support attendant to conducting a pest management program. Of course, the number of acres in a pest management program will vary yearly depending on production costs and the market value of cotton.

We hope that the above comments will be useful in preparing the final environmental statement.

Edwin L. Kirby

EDWIN L. KIRBY
Administrator

UNITED STATES DEPARTMENT OF AGRICULTURE
ECONOMIC RESEARCH SERVICE
WASHINGTON, D.C. 20250

SEP 16 1975

OFFICE OF THE ADMINISTRATOR

SUBJECT: Review of "Draft Environmental Statement for Trial Boll Weevil Eradication Program"

TO: F. J. Mulhern, Administrator
Animal and Plant Health Inspection Service

We appreciate the opportunity to review this report. The selection of the Virginia - Carolina area for an expanded trial project should provide a good basis for determining whether the program should be conducted on a nationwide basis. If the program is economically feasible in the marginal Virginia - Carolina area, it should be feasible in the major cotton producing areas.

The report includes a substantial economic analysis of the proposed program but no economic analysis of the recent Mississippi effort. The economic section indicates that over the three year period under study the program would provide a greater net return than current control methods but a lower return than pest management. This and other aspects of the report raise a number of questions.

The eradication program appears to be offered as an alternative to the current pest management program. Certainly, the pest management program should continue even if the boll weevil is eradicated. The report implies a major share of current control costs are to control boll weevil. However, in most areas other insects, such as the Heliothis complex, are a greater problem. The report does not indicate how many insect sprays would be required after eradication of the boll weevil or how boll weevil eradication might improve efforts to control the remaining insect pests.

This high-lights some of our reactions to the report. Enclosed are more detailed comments on the report prepared by two of our economists, Fred Cooke and Ted Eichers. If you or your staff have questions you may contact either of them directly.

Quentin M. West

QUENTIN M. WEST
Administrator

Enclosures

[illegible]

Pesticide [illegible]

J. [illegible]

[illegible]

The report includes a [illegible] program [illegible] integrated effort. [illegible] the three year period [illegible] ... [illegible] ... [illegible]

[illegible] the current [illegible] should [illegible] The report [illegible] such as the [illegible] report does not [illegible] alternative [illegible] might [illegible] pos[illegible]

The high lights some of our [illegible] detailed comments on [illegible] [illegible]

UNITED STATES DEPARTMENT OF AGRICULTURE
ECONOMIC RESEARCH SERVICE
Commodity Economics Division
Delta Branch Experiment Station
Stoneville, Mississippi 38776

August 29, 1975

AIR MAIL

SUBJECT: Review of "The Environmental Statement for Trial Boll Weevil Eradication Program"

TO: Velmar Davis, Deputy Director
Natural Resource Economics Division

In response to a request for the fibers group to review a draft of "The Environmental Statement for Trial Boll Weevil Eradication Program," Irving Starbird forwarded this document to me. Below are my observations and comments on this draft.

The first several pages of this document goes into considerable detail as to the economic importance of the boll weevil as an agricultural pest in the United States. The statement that the boll weevil is the most important agricultural pest in the United States was probably valid some years ago but in light of new insect problems in cotton, particularly the Heliothis complex, it is doubtful that this statement continues to be true. The statement that the boll weevil costs the U.S. economy $200 to $300 million annually in losses and control may not be valid in 1975. The Heliothis complex has become much more important and certainly now dominates insect control requirements in most of the rain grown portion of the Cotton Belt.

The report continues with references to the possibility of reducing needs for insecticide applications to control the spider mite and Heliothis complex if the boll weevil is eradicated. There is a good deal of documentation to support this position. However, it should be pointed out again that the boll weevil has become an insect almost of no consequence in the mid-South and westward through Texas, yet inputs for spider mites, plant bug complex, and particularly the Heliothis complex have steadily increased as these insects become more difficult to control. This report completely ignores the increase of resistance in the tobacco budworm, particularly to all insecticides currently available.

In the principal state included in this study, South Carolina, the survey at the Pee Dee Experiment Station in 1974 indicated that 15 applications of insecticides were made on cotton by commercial cotton farmers in that area. Only two of these applications were specifically for the boll

weevil. These two applications for boll weevils were made early in the growing season and certainly had an adverse effect on predator population in the cotton fields in this area which probably resulted in an increased need for control of the Heliothis complex. However, in this survey farmers reported that 12 to 13 applications were made solely because of the boll worm-bud worm complex. There were weevils in the field at the time of most of these applications, but they were not at a level to be considered of economic consequence.

The tobacco bud worm particularly raises serious questions as to the ability to reduce significantly the number of insecticide applications if the boll weevil are eradicated in some areas. This insect, the tobacco bud worm, is considered completely uncontrollable in the Rio Grande Valley and the Coastal Bend of Texas, and is approaching this level of problem in the cotton growing regions of the mid-South. It would appear that an integrated pest management program is going to be required to control the Heliothis complex in the future.

The highly dynamic nature of cotton production, that is the acreage produced, should be taken into account in any economic evaluation of a boll weevil eradication program. Dramatic increase in cost of production beginning in 1973 and continuing to date, coupled with rather widely fluctuating prices for cotton, make it likely that acreages will fluctuate widely within the next few years. The acreage estimates used for Virginia, North Carolina, and South Carolina would not apply to 1975 conditions. The August 1 estimates for 1975 for these states are as follows: Virginia, no cotton; North Carolina, 57,000 acres; and South Carolina, 120,000 acres for a total of 177,000 acres in the three states.

It would appear that some look at the long-range competitive position of cotton in these areas would be appropriate before this study is undertaken so that likely extreme variations of acreage can be taken into account. These variations may or may not have significant effect on the effectiveness of any boll weevil eradication program in this area.

One method of analysis completely ignored in this statement was a look at competitive positions of other crops under present production costs and expected returns to these crops. This statement completely ignores the possibility that the cost of producing cotton may be such that this crop will be grown on the ever-decreasing acreage in these areas. Also, the yield losses indicated in the latter part of the report in no way take into account the possibility of switching to other crops which would give a higher return than those indicated if the boll weevil cannot be controlled. Other crops could be substituted which would give better income.

On page 23, the statement that three applications of insecticide made on 5-day intervals from August 1 to August 15 will hold Heliothsis populations below economic levels does not appear to be able to be substantiated in light of current conditions in this area or other areas where the boll weevil is not considered a serious problem. It should be pointed out that on page 45 the assumption that the value of cotton would fall from $164.47 an acre to $50.32 per acre as a result of man's inability to control boll weevils with insecticides does not appear to be reasonable. There is little indication that the organophosphates will be completely ineffectual for insect control within the next five years. These materials are extremely effective on boll weevils even though repeated applications are required in years of serious boll weevil infestations.

On page 46, the implication is made that all insect control in these three states is extended for boll weevil control. Reports indicate that this is simply not the case. Rather, that efforts to control the tobacco bud worm and the cotton boll worm account for the largest portion of expenditures for insect control in cotton in these three states. Again, it should be pointed out that there is little doubt that if boll weevils can be eradicated; and if no other insect problems such as plant bugs cause a need for early insecticide applications, that the need for insecticides for Heliothis control will be less. One serious unanswered question concerning the Heliothis complex is to what extent will this complex of insects require insecticide controls once the boll weevil is eradicated.

Beginning on page 42, section 4 entitled "Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity." This section is extremely confusing and the methods used to explain the computations of the tables of the economic statement are extremely unclear. Particularly on page 45, there is a statement in paragraph 2 that there is a consensus among boll weevil experts that the present control system (that is existing insecticides) will be lost beginning in 5 years and will be completely lost by the 10th year. The present insecticides used to control boll weevils have been in use longer than 10 years; and to reiterate, these insecticides continue to be effective.

Table 1 must be accepted as presented except that any evaluation in this area should probably drop the consideration of the state of Virginia unless it is likely the cotton will be replanted there in the future. Past history of cotton leaving a region where only a small acreage is produced indicates that the infrastructure, particularly ginning, warehousing and marketing to support cotton production does not come back. This table again tends to give the impression that all insect control in these three states are carried out solely for the boll weevil. This statement does not seem to be correct.

Table 2, Page 69. This table should be completely redone to take into account the change in cotton acreage which occurred since 1973 and should consider the potential acreage in the future when costs and price of cotton are considered and also comparative advantage when compared with other crops produced in the area.

Referring back to Page 46, in the explanation of computations of economic justification of this proposal. This explanation fails to point out that the direct cost of the eradication program over the specified period of time is greater than the benefits which would be realized from this program within that time. It is recognized that these benefits would accrue long after the program is completed. Yet there is then the question of the integrated pest management control for other insects which will be discussed later.

On Table 2, footnotes should be provided to clearly indicate the prices used for cotton lint and cottonseed in computations of this table when it is refigured to take into account recent changes in cotton acreages in these three states. The terminology used in Table 6 is very poor. Benefits should be described as gross benefits or gross increases in output as the cost of the programs associated with achieving these benefits are not included. They are gross benefits. The implication is left that they are total benefits.

Table 7 clarifies this problem somewhat and is a good bit more straightforward than Table 6. These numbers using the assumptions presented in Tables 3 and 4 appear to be valid. This table seems to indicate an economic advantage for the use of pest management for these three states rather than eradication of the boll weevil. The figure under net benefits in Table 7 for eradication over pest management is a negative $30,359,000 indicating that pest management would result in improvement in income in the conditions stated in this paper are $30,359,000 over eradication. That part of Table 7 that considers no chemical insect control as an alternative does not seem to be reasonable at this time. It might be reasonable in the future if the organophosphates were banned from use in agriculture or did become ineffective but neither of these seem to be imminent within a 5-year period.

The figure in Table 7 under "Cost of Programs at Left", pest management when compared with costs of present controls should be $22,757,663 rather than $19,761,000. As both of these numbers are negative, it implies that the pest management would be much cheaper so there is an error in Table 7 for the pest management costs when compared with present control costs. This is derived by multiplying cost of present control $13,141,915 times 3 which equals $40,325,745 then multiplying the cost of pest management program $5,855,994 times 3 which is $17,567,982. The cost of pest management program is subtracted from the cost of present control, and you get $22,757,663 reduced costs associated with pest management when compared with present controls.

Table 8 appears to add nothing to the economic analysis of this proposal. I found it impossible to verify the numbers under benefits or relate them to anything presented in other tables. Also, I could not verify the cost figure for present control on this table. The only benefits figure that I could verify was the negative $165,705,000 associated with loss of effective chemical control of the boll weevil.

<u>Summary</u>: This statement appears to give unwarranted emphasis to the importance of the boll weevil under today's conditions in cotton production and in American agriculture. This is not to say that the boll weevil is still not a very important pest but it is extremely misleading to say that it is the most important pest in cotton or in American agriculture.

The whole question of the Heliothis complex is not given enough attention. Indications in areas where the boll weevil is not a severe problem would indicate that the Heliothis complex will be with us to some degree whether we have to make applications of insecticides for the boll weevil or not. There is also the question of increasing problems from the plant bug complex which could result in a need for early season insect control for this group which might negate the effectiveness of eradicating the boll weevil. The economic explanation seems to be unduly complex and too little attention given to the comparative costs between pest management programs and eradication. It would appear that it would be reasonable to look further into the comparative advantage of using pest management techniques as opposed to eradication of the boll weevil particularly in this area of declining cotton acreage.

There seems to be a need to look at the comparative advantage of cotton in the future for various cost of production and price expectations when compared with other crops that might be produced in the area. The economic explanations seem to be unduly complex and somewhat misleading. Table 7 is the most meaningful table if the error which has been noted is corrected.

It is very likely that an effective, meaningful integrated pest management program for cotton is dependent upon the eradication of the boll weevil. The assumption that the eradication of the boll weevil will essentially eliminate insect control costs in Virginia, North Carolina, and South Carolina does not seem to be valid. It appears that integrated pest management programs for other cotton insects will be needed after the boll weevil is eradicated. The effectiveness of these pest management programs are probably dependent upon eradication of the boll weevil.

Dr. Velmar Davis August 29, 1975

If you have any questions concerning this review, please let me know.

Sincerely,

Fred T. Cooke Jr.

FRED T. COOKE, JR.
Agricultural Economist

cc: Irving Starbird

UNITED STATES DEPARTMENT OF AGRICULTURE
ECONOMIC RESEARCH SERVICE
WASHINGTON, D.C. 20250
National Economic Analysis Division

August 21, 1975

SUBJECT: Review of Statement on APHIS Boll Weevil Eradication Program

TO: Velmar Davis, Deputy Director
Environmental Studies

I have looked at the "Draft Environmental Statement for Trial Boll Weevil Eradication Program." This statement reports on: (1) a proposed action to conduct a 3 year trial boll weevil eradication program on about 0.5 million acres of cotton in Virginia, North Carolina and South Carolina to determine if such a program would be feasible on a national basis and (2) a review of a similar program conducted in South Mississippi from 1971 to 1973.

At the completion of the Mississippi effort the Pilot Boll Weevil Eradication Experiment Technical Guidance Committee reported, "That it is technically and operationally feasible to eliminate the boll weevil as an economic pest from the United States by the use of techniques that are ecologically acceptable." However, instead of immediately embarking on a national eradication program it was decided to conduct another pilot test in Virginia, North Carolina and South Carolina.

The Virginia-Carolina area should provide a good test of the program. If the program is economically feasible in a marginal area such as Virginia and the Carolina's it should be economical in the more efficient cotton producing areas. The proposal for the Virginia-Carolina project includes a substantial economic cost benefit analysis section which indicates that the proposed program would be economically superior to current chemical control practices. But the 3 year net gain would be less than a fully implemented pest management program. The detailed background for some of the cost and benefit estimates are not included. Also, the net income analysis probably should cover more than the 3 year study period, as the boll weevil control costs for the eradication program would be zero after the third year, but the benefits would continue. It appears on the basis of the economic analysis presented, that when viewing a longer period such as 5 to 10 years the program would be economically justified. Net returns over the pest management program would be about $7 million in 5 years, and $60 million in 10 years (table 1).

Whether or not the eradication program is carried out the pest management program should continue. Then there is a question as to over-lapping costs and benefits of the two programs. The whole matter of pest management in relation to the eradication program should be given considerably more attention than is shown in this report.

A serious criticisim of the report is that there was no economic analysis of the 1971-73 Mississippi Pilot program. The review of this activity, which constitutes half of the report, deals with the test procedures, areas covered and insect population counts. It would appear that an actual cost-benefit analysis of this activity would have been more meaningful than the hypothetical cost-benefit analysis of the proposed Virginia-Carolina program. Possibly the Virginia-Carolina cost benefit estimates are based on the Mississippi effort but this is not specifically stated.

Much of the eradication benefit would appear to be in reducing early season spray activity so that predator populations of other pests such as the bollworm and tobacco budworm could build up. Therefore, the bollworm and tobacco budworm would be easier to control and fewer overall sprays would be required for cotton insect control.

Since the boll weevil was introduced in the U.S. before the turn of the century it appears rather unlikely that present control would be completely lost in 5 to 10 years, as cited in the report.

The impact of demand elasticities on growers' income has not been taken into consideration. Reduced cotton yields without the program should result in higher grower returns. The impacts of higher cotton prices would result largely in higher consumer costs for cotton goods.

Ted Eichers
TED EICHERS
Agricultural Economist
Inputs and Finance Program Area

North Carolina Department
of Administration

OFFICE OF
INTERGOVERNMENTAL
RELATIONS

EDWIN DECKARD
DIRECTOR

JAMES E. HOLSHOUSER, JR., GOVERNOR • BRUCE A. LENTZ, SECRETARY

October 6, 1975

USDA, APHIS
1403 Varsity Drive
Raleigh, North Carolina

Dear Sir:

Re: Draft Environmental Statement for Trial Boll
Weevil Eradication Program, Virginia, South
Carolina, and North Carolina. SCH # 100-75

Enclosed you will find comments on the above reference, for your use and file.

Sincerely yours,

Jane Pettus

Jane Pettus (Miss)
Clearinghouse Supervisor

JP:mw

Enclosure

116 WEST JONES STREET RALEIGH 27603 (919) 829-2594

8 October 75

MEMO TO : Jane Pettus

FROM : Art Cooper

SUBJECT : Review of Draft Environmental Impact Statement for Trial Boll Weevil Eradication Program, Virginia, South Carolina, and North Carolina - State Clearinghouse #100-75

Review of the subject draft environmental impact statement has been completed by DNER and the following comments are submitted for your consideration.

We anticipate no significant adverse forestry effects due to the two pesticides to be used in the eradication program. However, honey bee kills could have an indirect adverse effect on the seed bearing ability of some forest species as bees are important in the pollination process.

Also unnecessary alarm could result from careless application of defoliants. Trees under forest conditions as well as more valuable shade trees could be affected. It is therefore suggested that special training of aerial applicators and an awareness of this possibility during the educational program should be carried out.

The N.C. Wildlife Resources Commission has also reviewed the subject document and has submitted their comments directly to Dr. Francis Mulhern with the USDA in Washington,D.C.

Thank you for this opportunity to comment on the subject draft EIS.

OFFICE OF
INTERGOVERNMENTAL
RELATIONS

EDWIN DECKARD
DIRECTOR

North Carolina Department
of Administration

JAMES E. HOLSHOUSER, JR., GOVERNOR • BRUCE A. LENTZ, SECRETARY

October 13, 1975

USDA, APHIS
1403 Varsity Drive
Raleigh, North Carolina

Dear Sir:

Re: Draft Environmental Statement for Trial
Boll Weevil Eradication Program, Virginia,
South Carolina, and North Carolina; SCH
File Number 100-75

Please find attached additional comment submitted on the above referenced project. These comments were omitted from our original letter to you dated, October 6, 1975. Please include these comments in your records.

Sincerely,

Jane Pettus

Jane Pettus (Miss)
Clearinghouse Supervisor

JP:mw

116 WEST JONES STREET RALEIGH 27603 (919) 829-2594

AGRICULTURAL
RESEARCH
SERVICE

WASHINGTON, D.C.
20250

UNITED STATES
DEPARTMENT OF
AGRICULTURE

OFFICE OF ADMINISTRATOR

OCT 20 1975

Subject: Draft Environmental Statement for the Trial Boll Weevil Eradication Program

To: F. J. Mulhern
Administrator, APHIS

Enclosed are comments from our staff on the subject draft statement which we hope will be useful in preparing the final statement. If discussion of any of our comments is desired, please feel free to contact the appropriate ARS personnel.

Ralph J. McCracken

Ralph J. McCracken
Associate Administrator

Enclosure

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

Washington, D. C. 20250

SEP 26 1975

SUBJECT: EVT - Draft Environmental Impact Statement
Trial Boll Weevil Eradication Program
Animal Plant Health Inspection Service

TO: James Lee
Deputy Administrator
Animal Plant Health Inspection Service

In response to your request of August 5, 1975, we have reviewed the subject draft EIS and have the following comment for your consideration.

The "Plan of Action," page 19, states that activities are to be carried out on 500,000 acres of land of which 5-10 percent is rolling hills. Activities listed on page 27 include destroying cotton and other necessary action to prevent volunteer cotton, etc. Actions which might result in leaving fields bare or unprotected during critical seasons may pose a significant erosion hazard. Provisions for temporary cover crops or other conservation measures to offset this hazard should be considered and featured in the plan.

Thank you for providing us the opportunity to review the report.

Jw Haas

Joseph W. Haas
Deputy Administrator
for Water Resources

NATIONAL AGRICULTURAL CHEMICALS ASSOCIATION

THE MADISON BUILDING • 1155 FIFTEENTH ST., N.W.

WASHINGTON, D. C. 20005

CABLE: NAGRCHEM

PH: 202 • 296-1585

September 2, 1975

Dr. F. J. Mulhern
Administrator
Animal and Plant Health Inspection Service
U. S. Department of Agriculture
Washington, D. C. 20250

Subject: Request for Comments on the "Draft Environmental Statement for Trial Boll Weevil Eradication Program" as released July 25, 1975.

Dear Dr. Mulhern:

After due consideration of the above named document the National Agricultural Chemicals Association has no comments to offer at this time. Meanwhile, the National Agricultural Chemicals Association does wish to express its appreciation for the invitation and opportunity to submit comments.

Sincerely,

William Hollis

William Hollis
Science Coordinator

WH/db

cc: Dr. E. F. Alder
Dr. W. H. Grimes
Dr. J. D. Early

DELTA Council

THE ORGANIZATION OF THE YAZOO-MISSISSIPPI DELTA

PROMOTING AND DEVELOPING THE ECONOMY AND SOCIETY OF ITS AREA

TELEPHONE: LELAND. MISS., 686-4041

STONEVILLE, MISSISSIPPI 38776

August 25, 1975

Dr. Francis J. Mulhern
Administrator
Animal and Plant Health Inspection Service
United States Department of Agriculture
Washington, D. C.

Dear Dr. Mulhern:

We have had the opportunity to view the draft environmental impact statement on the proposed three-year trial boll weevil eradication program and wish to endorse both the statement and the proposed program.

Although Mississippi is not in the trial program area, the results of this program will have far-reaching benefits throughout the entire "boll weevil area" of the Cotton Belt. In addition, elimination of the boll weevil should result in great environmental and economic benefits.

Yours very truly,

B. F. Smith

B. F. Smith
Executive Vice President

BFS/dl

ROBERT R. COKER
PRESIDENT & TREASURER

S. PRESSLY COKER, JR.
VICE PRESIDENT & SECRETARY

EDGAR H. LAWTON, JR.
VICE PRESIDENT

COKER'S PEDIGREED SEED COMPANY
DAVID R. COKER (1870-1938) FOUNDER
COKER'S PEDIGREED SEED BLOOD WILL TELL TRADE MARK REGISTERED
THE GUARANTEE OF QUALITY
HARTSVILLE, S.C.
U. S. A.

ZIP CODE: 29550
P. O. BOX 340
PHONE: AREA 803 NO. 332-8151
CABLE: CPSCO
TELEX 573-343

August 27, 1975

Dr. Frank J. Mulhern, Administrator
Animal and Plant Health Inspection Service
Room 316-A
U. S. Department of Agriculture
Washington, D. C. 20250

Dear Dr. Mulhern:

I have just finished reading the USDA Environmental Statement for Trial Boll Weevil Eradication Program which was prepared by you and your associates in APHIS. This is one of the most complete, factual, and convincing documents of its kind that it has ever been my privilege to see.

I should like to express my deep appreciation and that of the members of the Beltwide Action Committee on Boll Weevil Eradication, and our congratulations on a job well done.

Again my sincere thanks to you and your associates in the USDA, and with kind personal regards, I am

Sincerely,

Robert R. Coker

Robert R. Coker, Chairman
NCC Beltwide Action Committee on
Boll Weevil Eradication

cc: A. R. Russell
J. R. Smith